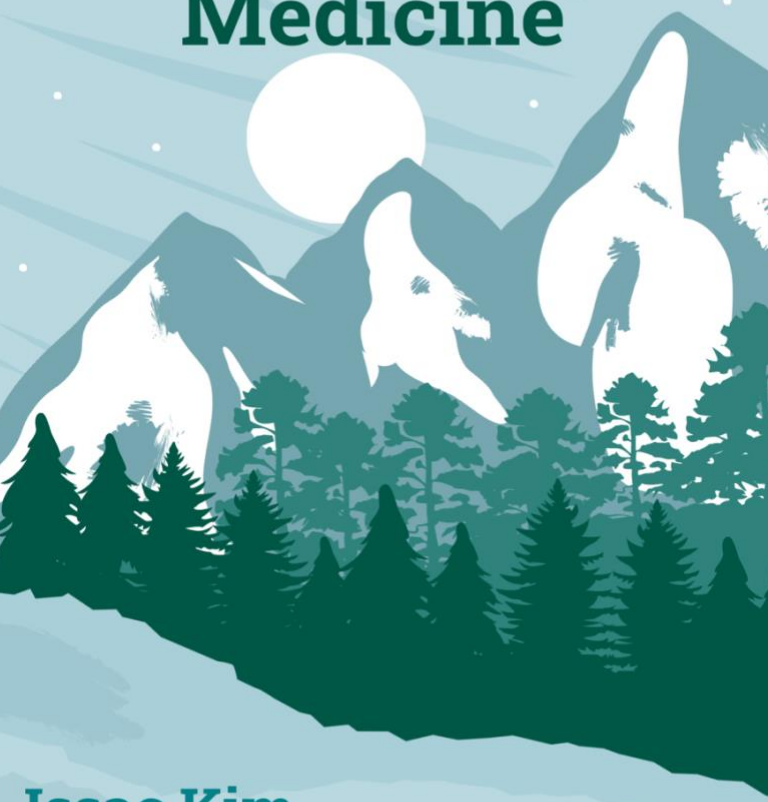
# Ottawa Handbook of Emergency Medicine



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5th Edition

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# Preface

## Introduction

Dear readers,

This handbook is a student-driven initiative developed in order to help you succeed on your emergency medicine rotation. It provides concise approaches to key patient presentations you will encounter in the emergency department. This guide has been peer-reviewed by staff physicians to ensure evidence is up-to- date and accurate. Based out of Ottawa, our hope is that this resource will benefit clerkship students and help bridge the emergency medicine knowledge gap from pre-clerkship to clinical practice.

Sincerely,
**Omar Anjum,** MD, MEng, FRCPC
Author and Editor

## How to Use this Guide

Topics are subdivided according to **background**, **assessment**, **investigations**, and **management**. 🔍 indicates there are images.
EMOttawa Blog Post: click here on applicable pages to be hyperlinked to a related EMOttawa Blog post for more info on this topic.

| **Background** |
| --- |
| This section provides common definitions, pathophysiology, etiology or risk factors for certain conditions. Differential diagnoses are also discussed ("Symptoms Approach" section). |
| **Assessment** |
| Common historical and physical exam features are mentioned here. Diagnostic criteria or techniques/methods used to aid in diagnosis may also be noted. |
| **Investigations** |
| Relevant labs, radiological evaluation and adjunctive tests are mentioned for consideration of diagnostic workup. |
| **Management** |
| General and disease-specific management approaches are discussed. Disposition and discharge criteria may also be noted. |

Key References: Used for further reading. Some sources are provided because they are deemed useful.

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# Resuscitation

# Airway

## Decision to Intubate

Failure to maintain or protect airway (e.g. low GCS, airway trauma)
Failure to ventilate/oxygenate (e.g. low or declining $SpO_2$, rising $pCO_2$)
Anticipatory (e.g. trauma, overdose, inhalation injury, anaphylaxis, inc. WOB)

## Assessment

| **Difficult Bag-Valve Mask Ventilation "BOOTS"** |
|---|
| **B** = Beard; **O** = Obese; **O** = Older; **T** = Toothless; **S** = Snores/Stridor |
| **Difficult Laryngoscopy** |
| Look for gestalt signs. Evaluate the 3-3-2 rule. Check for signs of obstruction, swelling, trauma. Assess neck mobility.<br>**Upper lip bite test:** Concern if patient cannot bite past vermillion border |
| **Difficult Supraglottic Device "RODS"** |
| **R** = **R**estricted mouth opening; **O** = **O**bstruction, **O**bese<br>**D** = **D**isrupted or **D**istorted anatomy; **S** = **S**tiff lung or cervical **S**pine |

## Airway Techniques

| **Temporizing Measures** |
|---|
| Chin lift/jaw thrust, BVM, suctioning, nasal airway, oral airway, LMA |
| **Definitive Airway** |
| Orotracheal/nasotracheal intubation, surgical airway (percutaneous or open cric) |

## Airway Methods

Rapid Sequence Intubation (RSI)
Awake intubation w/ topicalization
Ketamine-facilitated intubation
Crash airway without meds

## Rescue Airways

LMA
Cricothyroidotomy

## Rapid Sequence Intubation (6Ps)

| **Preparation** |
|---|
| Prepare equipment and medications, use checklist if available |
| **Pre-Oxygenation** |
| 100% $FiO_2$, employ PEEP valve to improve recruitment |
| **Pre-Treatment (Optional)** |
| Increased ICP: fentanyl 3µg/kg<br>Hypotension: fluids/vasopressors (infusion or push-dose)<br>Acidosis: bicarb (controversial), consider maintaining spontaneous respiration<br>Anxiolysis: midazolam 2-4mg |
| **Positioning** |
| Sniffing position, ramped position if obese, adjust bed height |
| **Paralysis with Induction** |
| Administration of sedative (i.e. Ketamine, Propofol, Etomidate) followed by muscle relaxant if indicated (i.e. Succinylcholine or Rocuronium) |
| **Place Tube with Proof** |
| Intubate patient and confirm tube placement (continuous waveform $EtCO_2$) |
| **Post-Intubation Management** |
| Post-intubation analgesia, ongoing sedation, ventilator management, further resuscitation. |

Airway Checklist

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 6.

# Breathing

## Definitions

| Acute respiratory failure = $pO_2$ <50mmHg +/- $pCO_2$ >45mmHg |
|---|
| **Hypoxic Respiratory Failure** |
| Diffusion problem: pneumonia, ARDS<br>V/Q mismatch: PE, Asthma, COPD<br>Shunt<br>Low ambient $FiO_2$: high altitude<br>Alveolar hypoventilation |
| **Hypercarbic Respiratory Failure, Normal Lungs** |
| Disorder of respiratory control: overdose, brainstem lesion, CNS disease<br>Neuromuscular disorders: muscular dystrophy, GBS, Myasthenia Gravis, ALS<br>Anatomic: trauma, ankylosing spondylitis, kyphosis/severe scoliosis |
| **Hypercarbic Respiratory Failure, Abnormal Lungs** |
| Increased airway resistance: AECOPD, asthma exacerbation<br>Decreased gas exchange: scarring, IPF |

## Assessment

| Look | Listen | Feel |
|---|---|---|
| Mental status, colour, chest wall movement, accessory muscle use<br>Paradoxical abdominal movement | Auscultate for breath sounds<br>Signs of obstruction<br>Air entering or escaping<br>Wheeze and stridor | Tracheal deviation, crepitus, flail segments, chest wounds |

## Investigations

Labs: CBC, electrolytes, cardiac enzymes +/- D-dimer +/- BNP, VBG
Tests: POCUS, CXR +/- CT Chest

## Management of Breathing

| Spontaneously Breathing Patient |
|---|
| Nasal prongs<br>Face mask, Non-rebreather face mask<br>High flow nasal oxygenation (i.e. MaxTech) |
| **Temporizing Measures for Inadequate Ventilation** |
| Bag-valve mask +/- nasal airway<br>CPAP/BiPAP: acute exacerbations of CHF, COPD, asthma |
| **Definitive Measures for Inability to Maintain/Protect Airway** |
| Oro-tracheal intubation<br>Surgical airway |
| **Additional Modalities** |
| Needle or finger thoracostomy for tension pneumothorax<br>Chest tube to drain pleural effusion/hemothorax/pneumothorax |

Key References: Journal of Critical Care 2016; 34: 111-115. Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 2.

# Circulation

## Causes of Shock

| | | |
|---|---|---|
| **Hypovolemic Shock** | Hemorrhage<br>GI losses | Third spacing<br>Dehydration<br>Over diuresis |
| **Obstructive Shock (Intra-Thoracic)** | Pulmonary embolism<br>Cardiac tamponade<br>Tension pneumo | Valvular dysfunction<br>Congenital heart disease<br>Air embolism |
| **Distributive Shock (Vasodilation)** | Septic shock<br>Anaphylactic shock<br>Neurogenic shock | Drug overdose<br>Adrenal crisis |
| **Cardiogenic Shock** | ACS<br>Cardiomyopathy | Cardiac structural damage<br>Dysrhythmias |

## Assessment

| **Clinical symptoms and signs suggestive of shock** | |
|---|---|
| Vitals: ↑HR, ↓BP, ↑RR | High initial lactate |
| Urine Output <0.5mL/kg/hr | Skin mottling |
| Capillary refill time >3 secs | Altered mental status |

## Investigations

Labs: CBC, electrolytes, BUN, Cr, LFTs, TnI, VBG, lactate
Tests: CXR, ECG, POCUS – RUSH exam (cardiac, IVC, lungs, aorta)

## Management

| |
|---|
| **Perfusion Goals** |
| Urine Output >0.5mL/kg/h, MAP >65mmHg, improved mentation, improved cap refill time, lactate clearance |
| **Hemorrhagic Hypovolemic Shock: fill the tank** |
| Control hemorrhage (tourniquets, direct compression, pelvic binders)<br>Fluids until blood available, balanced transfusion (1:1:1 of pRBCs:platelets:FFP) |
| **Obstructive Shock: alleviate obstruction** |
| Tension pneumothorax: needle decompression then chest tube<br>Cardiac tamponade: IV crystalloids, pericardiocentesis<br>PE: IV crystalloid, inotropes, thrombolysis |
| **Distributive Shock: source control, squeeze the pipes** |
| Anaphylaxis: Epinephrine IM, IV fluids, antihistamines if symptomatic, corticosteroids<br>Sepsis: Broad-spectrum antibiotics, IV fluids +/- norepinephrine |
| **Cardiogenic Shock: support forward flow** |
| Norepinephrine 0-20µg/min, dobutamine 0-5µg/kg/min<br>Treat underlying cause: cath lab, mechanical circulatory support (IABP, Impella, VAD, ECMO), heart transplant |
| **Cellular Toxins** |
| Antidotes for various toxins (see Toxicology) |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 6.

# Trauma Resuscitation

## Primary Survey

| 1. Airway | 3. Circulation |
|---|---|
| Assess patency of airway, look for obstruction (blood, emesis, teeth, foreign body), ensure C-spine precautions, airway management | Assess LOC, signs of shock (HR, BP, skin color, urine output, base deficit), sources of bleeding (external, chest, abdomen, pelvis, femur) |
| **2. Breathing** | **4. Disability** |
| Expose chest, assess breathing, auscultate for breath sounds, rule out tension pneumothorax | GCS assessment<br>Neurological evaluation including pupils |

| 5. Exposure/Environment |
|---|
| Fully expose and assess patient<br>Logroll patient to inspect for injuries, spinous tenderness and rectal exam for high-riding prostate and tone<br>Keep patient warm to prevent hypothermia |
| **Adjuncts** |
| **eFAST Exam:** subxiphoid pericardial window, perisplenic, pelvic/retrovesical, bilateral anterior lung<br>**Portable X-ray:** chest, pelvis, grossly deformed limbs<br>**ECG:** evaluate for dysrhythmias |

## Investigations

Bloodwork: CBC, lytes, BUN, Cr, glucose, lactate, INR/PTT, fibrinogen, ß-hCG, tox bloodwork, T+C, U/A
Imaging: CT (selective vs. pan-scan) for stable patients; unstable patients may require emergent OR

| Trauma Triad of Death |
|---|
| Coagulopathy<br>Hypothermia<br>Acidosis |

## Management

| General Resuscitation |
|---|
| Immediate hemorrhage control (Stop the Bleed)<br>Blood transfusion: balanced resuscitation to avoid dilutional coagulopathy<br>Tranexamic acid: 1g IV bolus then 1g IV over 8 hours<br>Consider permissive hypotension |
| **Head Trauma** |
| Seizure management/prophylaxis, treat suspected raised ICP, neurosurgical intervention for severe head injury/bleeds |
| **Spinal Cord Trauma** |
| Immobilization, treat neurogenic shock (goal MAP >85), consult spine service |
| **Chest Trauma** |
| Airway management, chest decompression, resuscitative thoracotomy in arrest, surgery for life-threatening injuries |
| **Abdominal Trauma** |
| Laparotomy for hemodynamically unstable and hollow organ injuries |
| **Orthopedic Injuries** |
| Reduce and immobilize when possible, irrigate open fractures, assess for neurovascular and skin compromise, adequate analgesia, consult ortho |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 36. ATLS Manual, ACS – 9th ed, 2012.

# Symptoms Approach

# Syncope

**Definition:** sudden and transient loss of consciousness and loss of postural tone accompanied by a rapid return to baseline

**Pathophysiology:** dysfunction of both cerebral hemispheres or the brainstem (reticular activating system) usually from hypo-perfusion

## Differential Diagnosis

| | | |
|---|---|---|
| **Cardiac** | **Rhythm Disturbances:** dysrhythmias, pacemaker issues<br>**Structural:** outflow obstruction (aortic stenosis, HOCM), MI<br>**Other CV diseases:** dissection, cardiomyopathy, PE | |
| **Non-Cardiac** | **Reflex (neurally mediated)** | **Vasovagal:** sensory or emotional reactions<br>**Orthostatic**: postural, dehydration<br>**Situational:** coughing, straining<br>**Carotid sinus pressure:** shaving<br>**Subclavian steal:** arm exercises |
| | **Medications** | CCBs, ß-blockers, digoxin, insulin<br>QT prolonging meds<br>Drugs of abuse |
| | **Focal CNS Hypoperfusion** | Hypoxia, epilepsy, dysfunctional brainstem |

## Assessment

History: syncope character (ask about exertion!), cardiac risk factors, comorbidities, medication/drug use, family history, orthostatic symptoms
Rule out seizure/stroke/head injury

Physical Exam: cardiac exam (murmurs, rate), CNS exam

## Investigations

**Labs:** CBC, glucose, lytes, extended lytes, BUN, Cr, CK/TnI, ß-hCG

| | |
|---|---|
| **H**eart rate/rhythm | Tachyarrhythmia, bradyarrhythmia |
| **E**lectrical conduction | PR (WPW, AV block), BBB and bifasicular block, long QT |
| **A**xis | Bifasicular block, new right axis from PE |
| **R**-wave progression | Early from WPW type A, late from cardiomyopathy |
| **T**all/small voltages | Small (pericardial effusion), large (HCM, AS) |
| **ST**/T changes | PE, STEMI, Brugada, ARVD |

## Management

| |
|---|
| **General** |
| ABCs, monitors, oxygen, IV access |
| **Cardiogenic Syncope** |
| Consult cardiology for workup +/- permanent pacemaker |
| **Non-Cardiogenic Syncope** |
| Benign causes or low-risk syncope: discharge with GP follow-up<br>Consider outpatient cardiac workup |
| **Risk Stratification Prediction Rules** |
| Canadian Syncope Risk Score |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 15. CMAJ 2011; 183(15): 1694-1695. CMAJ 2016; 188(12): E298.

Canadian Syncope Risk Score

# Altered Mental Status

**Definition:** decrease in LOC caused by either diffuse CNS dysfunction (toxic/metabolic causes) or primary CNS disease

## Differential Diagnosis

| **Drugs** |
|---|
| Abuse: Opiates, benzodiazepines, alcohol, illicit drugs<br>Accidental: Carbon monoxide, cyanide<br>Prescribed: ß-blockers, TCAs, ASA, acetaminophen, digoxin<br>Withdrawal: Benzodiazepines, EtOH, SSRIs |
| **Infection** |
| CNS: meningitis, encephalitis, cerebral abscess<br>Systemic: sepsis, UTI, pneumonia, skin/soft tissue, bone/joint, intraabdominal, iatrogenic (indwelling lines or catheter), bacteremia |
| **Metabolic** |
| Kidneys: electrolyte imbalance, renal failure, uremia<br>Liver: hepatic encephalopathy<br>Thyroid: hyper or hypothyroid<br>Pancreas: hypoglycemia, DKA, HHS |
| **Structural** |
| Bleeds: ICH, epidural hematoma, subdural hematoma, SAH<br>Brain: Stroke, seizures, surgical lesions, hydrocephalus<br>Cardiac: ACS, dissection, arrhythmias, shock |

## Assessment

History: collateral from family/friends/EMS, onset and progression, preceding events, past medical history, medications, history of trauma, baseline functional status

Physical Exam: ABCs, primary survey, vital signs including temp and glucose, neuro exam (GCS and focal neurological deficits)

## Investigations

Labs: CBC, lytes, glucose, BUN, Cr, LFTs, INR/PTT, serum osmolality, VBG, troponin, urinalysis, toxicology panel, septic workup as needed

Tests: ECG, CXR, CT head

## Management

| **General** |
|---|
| Monitors, oxygen, vitals, IV access<br>Airway management for declining GCS and inability to protect airway |
| **Treatment** |
| Treat underlying cause, universal antidotes (**D**extrose, **O**xygen, **N**aloxone, **T**hiamine), broad-spectrum antibiotics, warm/cool, BP control |
| **Disposition** |
| Consider admission for working up underlying cause |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 16.

# Headache

## Common Types

Migraine: **POUND** (**P**ulsatile, **O**nset 4-72hrs, **U**nilateral, **N**/V, **D**isabling intensity), photophobia/phonophobia, chronic, recurrent, +/- aura
Cluster: unilateral sudden sharp retro-orbital pain, <3 hours usually at night, pseudo-Horner's symptoms, precipitated by alcohol/smoking
Tension: tight band-like pain, tense neck/scalp muscles, precipitated by stress or lack of sleep

## Differential Diagnosis

| Intra-cranial | Extra-cranial |
|---|---|
| **Bleed:** epidural, subdural, subarachnoid, intracerebral hemorrhage<br>**Infection**: meningitis, encephalitis, brain abscess<br>**Increased ICP**: mass, cerebral venous sinus thrombosis | Acute angle closure glaucoma<br>Temporal arteritis<br>Carotid artery dissection<br>CO Poisoning<br>Pregnancy-related headaches |

## Assessment

History: red flags (sudden onset, thunderclap, exertional onset, meningismus, fever, neurological deficit, AMS), symptoms of increased ICP (persistent vomiting, headache worse lying down and in AM)
Physical Exam: vitals, detailed neuro exam (cranial nerves, gait, coordination, motor/sensory, reflexes), neck for meningeal irritation, eye exam (slit lamp, IOP), temporal artery tenderness

## Investigations

Neuroimaging to rule out deadly causes. Most benign headaches do NOT need further investigation. Refer to Ottawa SAH Rule.
LP: if CT head negative (>6h from onset) but strong suspicion of SAH
ESR/CRP: if suspect temporal arteritis

## Management

| Common Benign Headache Regimen |
|---|
| **Fluids**: No clear evidence but consider in dehydrated patient<br>**Antidopaminergic**: Metoclopramide 10mg IV<br>**Antihistamine:** Diphenhydramine 25mg IV<br>**Analgesic:** Acetaminophen 1g PO<br>**NSAIDs:** Ketorolac 10-30mg IV or Ibuprofen 600mg PO<br>**Steroids**: Dexamethasone 10mg PO/IV (rebound migraine prophylaxis) |
| **Non-Traditional Uses** |
| **Cluster Headaches**: oxygen, Sumatriptan, Verapamil<br>**Refractory Headaches:** Magnesium, Lidocaine, Propofol, Ketamine, Valproate<br>**Nerve Blocks**: greater occipital nerve, sphenopalatine block, trigger points |

**EMOttawa Blog Posts:** Migraine, Subarachnoid Hemorrhage, Podcast

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 20. Headache 2016; 56: 911-940.

# Head Trauma

## Common Injuries

**Epidural Hematoma (EDH):** Often temporal bone fracture resulting in middle meningeal artery injury; primarily a disease of the young; rare in elderly or children <2 due to tight attachment of dura to skull; temporary improvement in condition with subsequent worsening is highly suggestive

**Subdural Hematoma (SDH):** most common; disruption of bridging veins; most commonly during acceleration-deceleration injuries; common in pts with brain atrophy (elderly, alcohol) as bridging veins transverse greater distances; slow venous bleeding delays symptoms; 20% present with bilateral SDH

**Mild Traumatic Brain Injury (aka Concussion):** most often due to direct contact, but also acceleration-deceleration injuries; defined as GCS13-15.

## Assessment

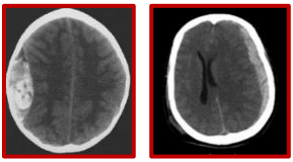
History: LOC, retrograde or anterograde amnesia, alteration in mental state at time of accident (feeling dazed, disoriented or confused), headache, photophobia, dizziness, N/V.

Physical Exam: vitals (assess for Cushing Triad of increased ICP: ↑ BP, ↓ HR, irregular breathing), c-spine for midline boney tenderness, neuro exam for focal neurological deficits

## Investigations

Refer to Canadian CT Head Rule in patients with minor head injury to assess appropriate application of the rule.

EDH SDH



Depending on size, may show midline shift (i.e. uncal herniation, ventricle shift)

| EDH |
| --- |
| Bi-convex, lentiform<br>Blood pools superior (epi) to dura, unable to cross suture lines |
| **SDH** |
| Crescent shaped<br>Blood pools between dura and arachnoid and is not limited by suture lines, only by dural reflections (i.e. falx cerebri, tentorium, falx cerebelli) |

## Management

| Concussion |
| --- |
| Outpatient management for uncomplicated cases: GCS 15, normal exam and CT head<br>24 hr period of cognitive rest with gradual return to work/play pending resolution of symptoms |
| **Epidural and Subdural Hematomas** |
| Consult neurosurgery for management (i.e. burr hole, craniotomy, decompressive craniectomy)<br>Reduce ICP: raise head of bead to 30°; IV Mannitol 1g/kg over 20 mins or HTS 1.25-5mL/kg over 5 mins; hyperventilation; diuretics<br>Reverse anticoagulation (i.e. give prothrombin complex concentrate if on Warfarin or Xa inhibitors; Praxbind for Dabigatran) |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2017; Chapter 34.

# Seizures

## Definitions

**Seizure:** Excessive abnormal neuronal activity associated with alternations in sensory, motor, autonomic and/or cognitive function

**Status Epilepticus:** unremitting seizure activity >5 mins in duration or recurrent seizure activity without intervening return to baseline

**Refractory Status Epilepticus:** no termination after 1st-or 2nd-line agents

**Psychogenic Non-Epileptic Seizures:** functional convulsions not associated with abnormal neuronal activity (usually variable convulsions, pelvic thrusting, forced eye-closure, responding or maintaining normal LOC, no post-ictal phase)

## Common Causes:

| Metabolic Disturbances | Infections |
|---|---|
| Hepatic encephalopathy<br>Hypoglycemia or hyperglycemia<br>Hyponatremia<br>Uremia | CNS abscess<br>Encephalitis<br>Meningitis |
| **CNS Lesions** | **Intoxication*/Withdrawal** |
| Brain metastases<br>Anoxia/hypoxia<br>Stroke<br>Arteriovenous malformations<br>CVST<br>Epilepsy<br>Bleeds: SAH, SDH, EDH, ICH | Bupropion*<br>TCAs*<br>Lithium*<br>Alcohol/benzos<br>Anti-epileptic drugs |

## Assessment

History: triggers, aura, memory before and after incident, appearance of convulsions, post-ictal phase, urinary incontinence, tongue biting, infectious symptoms, sensorimotor symptoms, med non-compliance, recent trauma, pregnancy, EtOH, immunocompromised, H/A, other injuries

Physical Exam: vitals (esp pupils), neuro exam (GCS, nystagmus, tone, reflexes)

## Investigations

Blood work: CBC, lytes, BUN, Cr, ß-HCG; if post-ictal confusion, status or first-time seizure add: LFTs, lactate, VBG, drugs of abuse screen, EtOH level, extended lytes, anti-epileptic drug levels (if applicable)

Tests: ECG, non-contrast CT head if first-time seizure, status, persistent focal deficits, change in seizure pattern, or prolonged post-ictal state

## Management of Status

| | |
|---|---|
| **1st-Line** | IV **Lorazepam** 0.1mg/kg (up to 4mg x2 doses)<br>IM **Midazolam** 0.2mg/kg (up to 10mg x2 doses) |
| **2nd-Line** | IV **Keppra** 60mg/kg IV OR<br>IV **Phenytoin or Fosphenytoin** 20mg/kg OR<br>IV **Valproate** 40mg/kg (contraindicated in pregnancy) |
| **Refractory Status** | RSI intubation, call ICU<br>IV **Propofol** 2-5mg/kg (infusion 3-5mg/kg/hr)<br>IV **Midazolam** 0.2mg/kg (infusion 0.05-2mg/kg/hr) |

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice - 9th ed, 2017; Chapter 92.

# Shortness of Breath

## Definitions

Tachypnea: RR >18 in adults
Hyperpnea: high minute ventilation to meet metabolic demands
Orthopnea: dyspnea lying flat
Paroxysmal Nocturnal Dyspnea: sudden dyspnea at night

## Differential Diagnosis

| Pulmonary | Cardiac |
|---|---|
| Airway obstruction<br>Respiratory failure (refer to Type 1 vs Type 2 in "Breathing" section)<br>Anaphylaxis<br>Pulmonary embolism<br>Tension pneumothorax | Pulmonary edema<br>Myocardial infarction<br>Cardiac tamponade<br>Pericardial effusion<br>Arrhythmias |
| **Toxic-metabolic** | **Neuro-endocrine** |
| Toxin ingestion (ASA, organophosphates, CO poisoning)<br>Sepsis<br>Acidosis (DKA, lactic, etc.) | Thyrotoxicosis<br>Guillain-Barre syndrome<br>Amyotrophic lateral sclerosis<br>Multiple sclerosis |

## Assessment

History: OPQRST, recent travel, trauma, PE risk factors (Wells Criteria, PERC rule), sick contacts
Physical Exam: appearance, signs of respiratory distress, cardiac/resp exam

## Investigations

Blood work: CBC, lytes, BUN/Cr, VBG, cardiac enzymes +/- D-dimer
Tests: ECG, POCUS, CXR (portable if unstable)

## Management

| General |
|---|
| Monitors, oxygen, vitals, IV access, ABCs |
| **Intubate** |
| If not protecting airway or significant respiratory distress |
| **Empiric Treatment** |
| **Trauma:** ATLS guidelines, decompress tension pneumo<br>**Anaphylaxis:** Epinephrine, fluids, +/- antihistamines, +/- steroids<br>**Cardiac Causes:** see various cardiac sections below<br>**Asthma/COPD:** oxygen, bronchodilators, corticosteroids +/- antibiotics<br>**PE:** DOACs as outpatient, LMWH, tPA for massive PE<br>**Infection:** antibiotics, steroids of obstructive lung disease |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 25.

# Chest Pain

## Differential Diagnosis

| Deadly Six (PET MAC) | Cardiac |
|---|---|
| **P**ulmonary embolism<br>**E**sophageal rupture/mediastinitis<br>**T**ension pneumothorax<br>**M**yocardial infarction<br>**A**ortic dissection<br>**C**ardiac tamponade | Pericarditis<br>Myocarditis<br>Endocarditis |
| **Respiratory** | **Gastrointestinal** |
| Pneumonia<br>Pleural effusion<br>Acute chest syndrome (sickle cell)<br>Lung or mediastinal mass | **Esophagus** – Mallory-Weiss tear, esophageal spasm<br>**Stomach** – GERD, dyspepsia/PUD<br>**Pancreas** - pancreatitis<br>**Gallbladder** - biliary colic, cholecystitis, cholangitis |
| **Muscoloskeletal** | **Other** |
| Intramuscular pain<br>Rib pathology | Panic attack<br>Herpes Zoster |

## Assessment

History: character of pain, cardiac risk factors (see HEART score), PE risk factors (see PERC rule), recent trauma, neuro symptoms
Physical Exam: appearance, cardiac exam, resp exam, neuro screen, vitals + pulse deficits

## Investigations

Tests: ECG, CXR +/- CTPA
Labs: CBC, lytes, abdo panel, troponin +/- D-dimer

## Management

| | |
|---|---|
| **General** | ABCs, monitors, oxygen, vitals, IV access, equipment |
| **ACS** | ASA, Nitro (avoid in RV infarct), Clopidogrel/Ticagrelor, UFH, STEMI protocol (PCI vs. thrombolytics) |
| **PE** | Anticoagulation +/- thrombolysis for massive PE |
| **Esophageal rupture** | Urgent thoracics consult, IV antibiotics, NPO, endoscopy and further imaging |
| **Tension pneumothorax** | Needle decompression then chest tube (4$^{th}$ or 5$^{th}$ ICS anterior axillary line) |
| **Tamponade** | Pericardiocentesis |
| **Dissection** | Urgent vascular consult, reduce BP and HR with IV labetalol, surgery vs. medical management |
| **Disposition** | Diagnosis and risk stratification dependent |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 26.

# Chest Pain Risk Stratification

## HEART Score

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Patients ≥21 years old presenting with symptoms suggestive of ACS | New STEMI >1mm or other new ECG changes, hypotension, life expectancy <1 year, non-cardiac medical/surgical/psychiatric illness |

**H = History**

0 = slightly suspicious
+1 = moderately suspicious
+2 = highly suspicious

**E = ECG**

0 = normal
+1 = No ST depression but LBBB, LVH, repolarization changes
+2 = ST depression/elevation not due to LBBB, LVH, or digoxin

**A = Age**

0 = age <45
+1 = age 45-64
+2 = age ≥65

**R = Risk Factors**

**Risk factors** = HTN, hypercholesterolemia, DM, obesity (BMI >30), smoking (current or smoking cessation ≤3 months), positive FHx (parent/sibling with CVD <65yo), atherosclerotic disease (prior MI, PCI/CABG, CVA/TIA, or PVD)

0 = No known risk factors
+1 = 1-2 risk factors
+2 = ≥3 risk factors or history of atherosclerotic disease

**T= Troponin (initial)**

0 = initial troponin ≤normal limit
1 = initial troponin 1-2X normal limit
2 = initial troponin >2X normal limit

| Interpretation | |
|---|---|
| Scores 0-3: 0.9 – 1.7% risk of MACE within 6 wks<br>Score 4-6: 12-16.6% risk of MACE<br>Score ≥7: 50-65% risk of MACE | Use the **HEART Pathway** (HEART score + delta TnI) to further lower risk of MACE (not prospectively validated but 1% risk of MACE in retrospective data) |

## PERC Rule

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Patients where pre-test probability of PE is considered to be low risk (<15%) | Moderate to high risk for PE |

**Patients can be safely ruled out and do not require further workup if no criteria are positive:**

Age≥50, HR≥100, SpO2<95%, hemoptysis, hormone use (OCPs, hormone replacement, estrogen), recent (≤4 weeks) surgery/trauma, prior PE/DVT or unilateral leg swelling

EMOttawa Blog Post

Key References: Neth Heart J. 2008; 16(6): 191-6. J Thromb Haemost 2008; 6(5): 772-80.

# Abdominal Pain

## Differential Diagnosis

| RUQ | Epigastrium | LUQ |
|---|---|---|
| Hepatitis<br>Biliary colic<br>Cholecystitis/Cholangitis*<br>Pancreatitis*<br>Pneumonia<br>Pleural effusion<br>PE* | Gastritis<br>Dyspepsia/PUD<br>Duodenitis<br>Pancreatitis*<br>Cardiac – ACS* | Pancreatitis*<br>Gastritis<br>Pneumonia<br>Pleural effusion<br>PE* |
| **Right Flank** | **Umbilicus** | **Left Flank** |
| Colitis<br>Perforation*<br>Obstruction*<br>Renal colic<br>Pyelonephritis<br>AAA* | Colitis<br>Perforation*<br>Obstruction*<br>Aortic dissection*<br>AAA*<br>Early appendicitis | Colitis<br>Perforation*<br>Obstruction*<br>Renal colic<br>Pyelonephritis<br>AAA* |
| **RLQ** | **Hypogastric** | **LLQ** |
| Appendicitis<br>Ectopic pregnancy*<br>PID, TOA<br>Testicular torsion, epididymitis, orchitis<br>Ovarian torsion<br>Renal colic | UTI (Cystitis)<br>Renal colic<br>Obstruction | Diverticulitis*<br>Ectopic pregnancy*<br>PID, TOA<br>Testicular torsion, epididymitis, orchitis<br>Ovarian torsion<br>Renal colic |

| Can't-Miss Diagnoses* | Risk Factors |
|---|---|
| **Ruptured Ectopic** | Hx of STI/PID, recent IUD, previous ectopic, smoking, fallopian tube surgery, tubal ligation |
| **Ruptured AAA** | Elderly, hx HTN/DM, smoking, trauma hx |
| **Pancreatitis** | Alcohol use, biliary pathology |
| **Cholangitis** | Charcot's Triad: fever, RUQ pain, jaundice |
| **Mesenteric Ischemia** | Elderly, CAD, CHF, dehydration, infection |
| **Obstruction** | Operative or malignant history, elderly |
| **Perforated Viscus** | Risk factors for diverticulitis or PUD, malignancy or instrumentation (i.e. colonoscopy) |
| **Comp. Diverticulitis** | Elderly, low-fibre diet, Western population |

## Assessment

History: OPQRST, associated symptoms (N/V, fever, chills, bowel movement, urinary symptoms, pelvic discharge/bleeding)
Physical Exam: abdominal exam +/- pelvic exam, cardiac/resp exam

## Investigations

**Labs:** CBC, lytes, BUN, Cr, LFTs, lipase, lactate, ß-hCG +/- CK/TnI
**Tests:** ECG, CXR, POCUS
Radiology performed U/S (biliary pathology, ectopic, AAA), CT abdo/pelvis

## Management

ABCs, NPO, analgesics, antibiotics, anti-emetics, consult surgery as needed

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 27.

# Pelvic Pain

## Differential Diagnosis

| Gynecological | | |
|---|---|---|
| **Ovaries:** Ruptured cyst, abscess, torsion<br>**Fallopian tubes:** Salpingitis, tubal abscess, hydrosalpinx<br>**Uterus:** PID, endometriosis, fibroids<br>**Pregnancy related (1st trimester):** Ectopic pregnancy, threatened abortion, ovarian hyperstimulation<br>**Pregnancy related (2nd-3rd trimester):** Placental abruption, round ligament pain, Braxton-Hicks contractions<br>**Other:** Bartholin abscess | | |
| **Urinary Tract** | **Urological** | **Other** |
| Urolithiasis<br>Pyelonephritis<br>Cystitis | Testicular torsion<br>Prostatitis | Sexual or physical abuse |

## Assessment

History: OPQRST, associated symptoms (vaginal bleeding, discharge, dyspareunia, bowel or bladder symptoms), pregnancy and sexual history

Physical Exam: vitals, abdominal exam

Pelvic exam (assess cervical motion tenderness, adnexal tenderness)

Speculum exam (look for discharge, blood, take samples as needed)

## Investigations

Labs: CBC, lytes, BUN/Cr, ß-hCG, +/- vaginal and cervical swabs

Tests: PoCUS – rule out ectopic, free fluid assessment

Formal abdo/pelvic ultrasound

## Management

| General |
|---|
| ABCs, IV access, analgesia, antiemetics, +/- admit and consult<br>For STIs/PID: safe sex practices, partner testing |
| **Ovarian Cyst** |
| Uncomplicated: analgesia with follow-up<br>Hemoperitoneum or hemodynamically unstable: surgery |
| **Ovarian Torsion/Testicular Torsion** |
| Surgical detorsion or removal |
| **Pelvic Inflammatory Disease** |
| **Severe infection:** admit with IV antibiotics (Cefoxitin 2g IV q6h IV + Doxycycline 100mg IV q12h x 24 hrs then switch to PO)<br>**Mild-moderate infection:** Ceftriaxone 500mg IM x 1 + Doxycycline 100 PO BID x 14 days |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 33.

# Back Pain

## Deadly Differential Diagnosis

| Spinal | Vascular |
|---|---|
| Cauda equina and spinal cord compression:<br>Spinal metastasis<br>Epidural abscess/hematoma<br>Disc herniation<br>Spinal fracture with subluxation<br>Meningitis<br>Vertebral osteomyelitis<br>Transverse myelitis | Aortic Dissection<br>Ruptured AAA<br>Pulmonary Embolism<br>Myocardial Infarction |

## Assessment

History: fracture history, cancer risk, infection risk, steroid use, **red flags** (**BACK PAIN**): **B**owel/Bladder dysfunction, **A**nesthesia (saddle), **C**onstitutional symptoms (night pain, weight loss, fever/chills), **C**hronic disease, **P**aresthesias, **A**ge >50, IVDU/infection, **N**eurological deficits

Physical: vitals + pulse deficits, inspect skin for infection/trauma, abdo exam for AAA, cardiac exam (aortic murmur), MSK lower back exam, neuro exam (lower extremity, reflexes, rectal tone), post void residual

## Investigations

Bloodwork: usually not indicated unless suspected infection (CBC, ESR, CRP)

Bedside U/S: rule out AAA, look for bladder distention post-void

PVR: cauda equina syndrome (PVR >200cc has 90% sensitivity for CES)

## Management

| |
|---|
| **Cauda Equina Syndrome** |
| Urgent MRI, spine consult, analgesia, IV Dexamethasone |
| **Aortic Dissection** |
| Immediate specialist consultation, IV Labetalol to control HR and BP |
| **Ruptured AAA** |
| Blood resuscitation, immediate OR if unstable |
| **Epidural Abscess or Vertebral Osteomyelitis** |
| MRI to definitively diagnose +/- bone scan (osteomyelitis), broad spectrum antibiotics, orthopedics consult |
| **MSK Back Pain** |
| Analgesia: Acetaminophen, NSAIDs<br>Multidisciplinary approach with GP follow-up |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 35.

# Vaginal Bleeding

## Differential Diagnosis

| Non-Pregnant (PALM COEIN) | Pregnant <20w |
|---|---|
| Polyps<br>Adenomyosis<br>Leiomyoma (fibroids)<br>Malignancy<br>Coagulopathy<br>Ovulatory dysfunction<br>Endometrial<br>Iatrogenic (i.e. drugs, surgery)<br>Not classified | **Cannot Miss**: ectopic pregnancy<br>Other: spontaneous abortion, molar pregnancy, subchorionic hematoma, implantation bleeding |
| | **Pregnant >20w** |
| | **Cannot miss:** uterine rupture, placenta previa, placental abruption, vasa previa,<br>Other: 'bloody show', cervical lesion, post-partum hemorrhage |

## Assessment

History: LMP, pregnancy complications, GTPAL, time and duration of bleeding, clots, signs/symptoms of blood loss (ie. anemia sx: fatigue, dyspnea, syncope, soaking; #pads/hr), trauma, past menstrual, reproductive & sexual hx
Physical Exam: Vitals (BP, HR), abdominal exam (localize pain, peritoneal S&S, size of uterus), speculum & bimanual exam (must r/o placenta previa first in 2nd/3rd trimester; cervical os, products of conception, lacerations/trauma, cervical motion and adnexal tenderness), fetal HR monitoring (if >20 wks)

## Diagnosis

**Labs:** Most important: determine if pregnant (qualitative as screening, if positive pursue quantitative b-hCG). CBC, type & screen, INR, PTT, Rh status, U/A
**Transabdominal Ultrasound (TAUS):** first step to attempt to confirm intrauterine pregnancy (IUP), if unable, then considered no definitive IUP (NDIUP)
**Transvaginal Ultrasound (TVUS):** if NDIUP on TAUS, used to confirm IUP
**Discriminatory Zone:** if b-hCG > 1,500 or b-hCG > 6,000, IUP should be visible on TVUS & TAUS, respectively. If not, suspect ectopic pregnancy.

## Management

**General**

**If unstable:** resuscitate with blood (O- until crossmatched) and crystalloid

**Non-Pregnant**

Most can be discharged home with close Gyne follow-up
**If unstable:** high dose IV conjugated estrogen q4-6h for 24h + Gyne consult + consider TXA
**If stable:** NSAIDs, short course of TXA during bleeding episodes, OCPs

**Pregnant**

Rho-GAM in all Rh (-) pts
**Spontaneous Abortion:**

- **If os is open:** attempt to remove products of conception to relive pain, if unsuccessful consult OB
- **If os is closed, patient febrile, uterus is tender:** suspect **Septic Abortion** - empiric IV Gentamycin & Clindamycin and consult OB
- **If os is closed and uterus is non-tender**: **Threatened Abortion** - expectant management, d/c home with close OB/GP F/U vs. **Missed Abortion** - Misoprostol 800 mcg vaginally or PO or surgical (D+C)
- Emotional Support: recognize trauma/grief accompanying miscarriage

**Ectopic Pregnancy (consult OB):**

- Expectant if stable and reliable – F/U in 2 days with repeat b-hCG
- Medical: Methotrexate 50 mg/m$^2$ IM if meets indications – F/U with OB
- Surgical (Dilation and curettage, evacuation, oophorectomy, etc.)

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 31.
EM:RAP C3, 2016; Non-pregnant Vaginal Bleed & Pregnant First Trimester Vaginal Bleeding

# Red Eye

## Causes of Red Eye

| | | |
|---|---|---|
| **Traumatic** | Foreign body<br>Corneal abrasion/ulcer<br>Subconjunctival hemorrhage<br>Caustic contamination<br>Blunt or penetrating trauma | Retrobulbar hematoma<br>Hyphema<br>Orbital compartment syndrome<br>Globe rupture |
| **Non-Traumatic** | Acute angle closure glaucoma<br>Retinal ischemia<br>Temporal arteritis<br>Conjunctivitis<br>Keratitis | Episcleritis<br>Scleritis<br>Uveitis<br>Endophthalmitis<br>Cellulitis (orbital or periorbital) |

## Assessment

History: Check for red flags such as severe pain, persistently blurred vision, proptosis, reduced pupillary light reflex, corneal epithelial defect, ciliary flush, pupils unreactive to light, soft contacts, neonate, immunocompromise

| **VVEEPPS plus Fundoscopic Exam** | |
|---|---|
| **V**isual acuity (with correction) | **P**upillary evaluation |
| **V**isual fields | **P**ressure determination (IOP) |
| **E**xternal exam | **S**lit lamp exam (consider fluorescein) |
| **E**xtraocular muscle movement | Fundoscopic exam |

## Investigations

Labs: CBC, ESR/CRP in monocular vision loss (r/o temporal arteritis)
Imaging: CT and US as needed to rule out foreign bodies, orbital cellulitis, fracture, globe pathology. Most red eyes do NOT need further investigation.

## Management

**Critical Diagnosis – Immediate Intervention**

**Caustic Contamination:** Irrigation with Morgan Lens until tear-film pH = 7.4, outpatient Ophtho
**Orbital Compartment Syndrome:** Lateral canthotomy and cantholysis, Ophtho
**Acute Angle Closure Glaucoma (Goal: IOP <35 or 25% reduction):** Timolol 0.5% 1gtt, Apraclonidine 1% 1gtt, Pilocarpine 1% 1gtt q15 mins, Prednisolone 1% 1gtt, Acetazolamide 500mg IV, Mannitol 1g/kg IV, Ophtho

**Emergent Diagnosis – Ophthalmology Consult**

**Penetrating Trauma or Corneal Ulcer or Open Globe:** Protect eye, analgesia, IV abx, tetanus prophylaxis. Avoid contact lenses
**Keratitis:** Topical anesthetic, remove foreign material, discuss abx/antivirals
**Episcleritis:** Artificial tears and ketorolac drops
**Scleritis:** NSAIDs, discuss steroids
**Anterior Uveitis:** 2 drops cyclopentolate 1%, discuss steroids
**Endophthalmitis:** Admit for IV vancomycin and ceftazidime
**Orbital Cellulitis:** IV abx with 2nd generation cephalosporin

**Urgent Diagnosis – Manage in ED Before Discharge**

**Foreign Body:** Topical anesthetic, removal under slit lamp with swab or 27-gauge needle. Outpatient Ophtho for rust ring removal for metallic objects
**Corneal Abrasion:** topical anesthetic
**Periorbital Cellulitis:** Amox/Clav 875 mg PO BID x 10 days

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 19.

# Monoarthritis & Polyarthritis

## Differential Diagnosis:

| Infectious | |
|---|---|
| **Septic Arthritis** RFs: young or elderly, low SES, IVDU, alcohol use disorder, DM, skin infections, chronic arthritis, recent intraarticular injections, prosthetic joint, immunocompromised<br>**Gonococcal Septic Arthritis** RFs: young, sexually active, STI hx (poly, asymm)<br>**Lyme Arthritis** (poly, asymm) | |
| **Peri-Articular** | **Crystal** |
| Bursitis, tendinitis, muscle strain | Gout, pseudogout (CPPD) |
| **Musculoskeletal** | **Other** |
| Fractures, injury, osteoarthritis | Hemarthrosis: spontaneous or traumatic, malignancy |

**Involves multiple joints:** RA, OA (knees, hips, spine), SLE, scleroderma, seronegative arthritis, polymyalgia rheumatica, viral arthritides (Gonococcal and Lyme arthritis)

## Assessment

History: PMHx, characterize pain, duration of symptoms, associated sx, hx of trauma, septic arthritis RFs

Physical Exam: Systemic: S&S of rheumatic disease; joints: warmth, redness, pain, effusion, deformity, ROM, pain with ROM

| | |
|---|---|
| **Gout** | 1st MTP, hx of kidney stones |
| **OA** | DIPs > PIPs, MCPs, worse with activity and better with rest |
| **Inflammatory (i.e. RA)** | MCPs and PIPs > DIPs, pain/stiffness that improves with activity, low grade fever, PMHx or FHx |
| **Septic** | Classic triad: fever (only 50% cases), joint pain, effusion |

## Investigations

**Labs:** Unable to rule out or diagnose specific etiologies, ↑CRP + ESR or ↑WBC may suggest inflammatory or septic arthritis, ↑serum urate suggests gout

**XR:** 4 signs of OA: joint space narrowing, subchondral sclerosis, subchondral cysts, osteophytes

**Arthrocentesis:** Can be diagnostic or therapeutic. Send for cell count & diff, culture, crystal analysis. Avoid if # suspected. Consult ortho if prosthetic joint.

## Management

| | |
|---|---|
| **Gout** | Do NOT start Allopurinol in acute flares<br>**NSAIDs:** Naproxen 500 mg BID, Ibuprofen 800 mg TID, Indomethacin 50mg TID<br>**Colchicine:** 1.2 mg PO loading dose, then 0.6 mg PO one hour later, then 0.6 mg PO daily until two days after resolution of gout flare. Can use in combo with NSAIDs or standalone<br>**Steroids** (2nd Line): Prednisone 20 mg BID with a tapering dose x 7-10d (rebound gout flare is common with steroid treatment) |
| **OA** | **Non-Pharmacological:** weight loss, exercise<br>**Pharmacological:** Tylenol 1 g PO TID, Celecoxib 100mg PO BID<br>**Topical:** NSAIDs, Diclofenac, Capsaicin<br>**Intra-Articular:** steroid or hyaluronic acid (equivocal evidence)<br>**Ortho Referral:** for consideration of joint replacement if failing conservative management |
| **Septic** | Requires admission. Empiric IV abx (Ceftriaxone & Vanco) later narrowed based on gram stain and cultures. Often requires arthroscopic joint irrigation or often I&D required for shoulders/hips |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 106. Tintinalli's Emergency Medicine – 9th ed, 2020. Chapter 284.

# Selected Emergencies

# Anaphylaxis

**Definition:** life-threatening immune hypersensitivity systemic reaction leading to histamine release, vascular permeability, and vasodilation
Common Triggers: foods (egg, nuts, milk, fruits), meds (antibiotics, NSAIDs), insect bites, local anesthetics, occupational allergens, aeroallergens
Differential Diagnosis: shock (of any etiology), angioedema, flush syndrome, asthma exacerbation, vancomycin infusion reaction

## Diagnostic Criteria:

| **Acute onset (minutes to hours) + ANY of the following three:** |
|---|
| Involvement of skin +/- mucosa WITH EITHER respiratory difficulty or low blood pressure |
| Exposure to likely allergen with 2 of 4 signs:<br>**Skin-mucosal involvement** (urticarial, angioedema, flushing, pruritis)<br>**Respiratory difficulties** (dyspnea, wheezing, stridor, hypoxemia, rhinitis)<br>**Low BP** (hypotonia, syncope, pre-syncope, headache, collapse)<br>**GI symptoms** (abdo pain, cramps, N/V) |
| Low blood pressure after exposure to known allergen |

## Assessment

General: TREAT FIRST, ABCs, monitors, oxygen, vitals, IV access
appearance, respiratory distress, visualize swelling (lips, tongue, mucous membrane)
History: exposure to any known or likely allergen, co-morbidities, recent medication use, family history, atopy

## Management

| **General Management** |
|---|
| **If need to protect airway:** Ketamine as induction agent<br>**Epinephrine:** 0.3-0.5mg IM (1:1000 conc.) to anterolateral thigh q5-10 mins<br>**Antihistamines:** Benadryl 50mg IV/PO (controversial)<br>**Steroids:** Methylprednisolone 125mg IV/Prednisone 50mg PO (controversial) |
| **Refractory Hypotension** |
| Epinephrine drip 1-10µg/min IV (titrate to desired effect)<br>Consider Norepinephrine 0.05-0.5µg/kg/min |
| **Patients with ß-Blockers** |
| If Epinephrine unsuccessful, Glucagon 1-5mg IV over 5-10 mins followed by 5-15µg/min infusion |
| **Disposition** |
| May discharge as early as 2 hours if stable.<br>Education to avoid allergen, consider allergy testing, Epi-pen prescription<br>**Meds at discharge:** may consider 2nd generation antihistamines, steroids not necessary |

**EMOttawa Blog Posts:** Anaphylaxis, Podcast Part 1, Podcast Part 2

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 109. The World Allergy Organization Journal 2011; 4(2): 13-37.

# Asthma

**Definition:** chronic inflammatory airway disease with recurrent reversible episodes of bronchospasm and variable airflow obstruction
Exacerbation Triggers: URTIs, environmental allergens, smoking, exercise

## Classification (CAEP/CTS Asthma Severity):

| **Respiratory Arrest/Fatal** |
|---|
| Appearance: altered mental status, cyanotic, decreased resp. effort<br>Vitals: low HR, high RR, low $O_2$ sat <90% despite oxygen<br>Exam: Silent chest – consider preparing for advanced airway intervention |
| **Severe** |
| Appearance: agitated, diaphoretic, labored respirations, difficulty speaking<br>Vitals: high HR, high BP, $O_2$ sat 90-95%<br>Exam: worsening resp. distress, exp/insp. wheezing, FEV1 <40% predicted |
| **Moderate** |
| Appearance: SOB at rest, cough, congestion, nocturnal symptoms<br>Vitals: $O_2$ sat >95%<br>Exam: exp. wheezing, FEV1 40-60% predicted |
| **Mild** |
| Appearance: SOBOE, chest tightness<br>Vitals: $O_2$ sat >95%<br>Exam: exp. wheezing, FEV1 >60% predicted |

## Assessment

History: triggers, recent infection, thorough asthma hx including prior exacerbations, hospitalizations + interventions/ICU stays, family history
Asthma Control Criteria: daytime symptoms <4/week, no exercise limitation, no absenteeism, no nocturnal symptoms, rescue puffer <4/week, normal PFT, exacerbations mild/infrequent
Physical Exam: vitals, sign of distress, accessory muscle use, respiratory exam

**Investigations:** CXR, ECG +/- VBG, +/- PEFR (to estimate FEV1), bloodwork (CBC – infection, lytes – potassium)

## Management

| **Treat Exacerbation ("0.5 - 5 - 50")** |
|---|
| Ipratropium bromide 0.5mg neb OR 4-8 puffs via MDI + spacer q20mins x 3<br>Salbutamol 5mg neb OR 4-8 puffs via MDI + spacer q20mins x 3<br>Prednisone 50mg PO<br>**NOTE:** MDIs are superior to nebs unless patient too tachypneic to use MDI |
| **Severe Asthma** |
| $MgSO_4$ 2g IV over 30 mins<br>Epinephrine 0.3mg IM then 5µg/min IV infusion<br>Ketamine 1mg/kg (in conjunction with BiPAP) |
| **Respiratory Failure** |
| Consider NIPPV first (BiPAP)<br>Intubate (LAST RESORT): Ketamine 1mg/kg IV + Succinylcholine 1.5mg/kg IV<br>Involve ICU early |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 73. CMAJ 1996; 155(1): 25-37.

# Chronic Obstructive Pulmonary Disease

**Classifying Severity:** based on GOLD Classification

| | | |
|---|---|---|
| **GOLD 1** | Mild | $FEV_1 \geq 80\%$ predicted |
| **GOLD 2** | Moderate | $50\% \leq FEV_1 < 80\%$ predicted |
| **GOLD 3** | Severe | $30\% \leq FEV_1 < 50\%$ predicted |
| **GOLD 4** | Very Severe | $FEV_1 < 30\%$ predicted |

**Risk Factors:** smoking (#1), occupational dust, chemical exposure
AECOPD Triggers: viral URTI, pneumonia, environmental allergens or pollutants, smoking, CHF, PE, MI ≥ 80% predicted

## Assessment

Cardinal Symptoms: ↑ SOB, ↑ sputum production, ↑ sputum purulence.
Key Elements on History: duration of symptoms, severity of airflow limitation, number of previous episodes (total/hospitalizations), co-morbidities, premorbid functional status, present treatment regimen, previous use of mechanical ventilation, use of home oxygen.
Clinical Signs of Severity: rapid shallow pursed-lip breathing, use of accessory muscles, paradoxical chest wall movements, worsening or new onset central cyanosis, peripheral edema, hemodynamic instability, decreased LOC or confusion, decreased $O_2$ sat.
*Consider PE if deteriorating & not improving with standard COPD therapy.*

## Investigations

Labs: CBC, electrolytes, VBG, lactate, serologies (triplex, COVID, etc)
Tests: CXR, ECG, pulse oximetry

## Management

Follow **GOLD Guidelines** for best practices

| |
|---|
| **Oxygen** |
| Venturi masks (high-flow devices) preferred over nasal prongs<br>**Target $SaO_2$:** >88% Goal PaO2 = 60-65mmHg |
| **Bronchodilators** |
| **SABA:** Salbutamol 2.5-5mg via nebulizer or 4-8 puffs via MDI with spacer q15mins x3 PRN<br>**Anticholinergic:** Ipratropium bromide 500µg via nebulizer or 4-8 puffs q15mins x3 PRN |
| **Systemic Corticosteroids** |
| Oral is equivalent to IV in most exacerbations<br>Oral Prednisone 40-60mg for 5-10 days<br>IV Methylprednisolone 125 mg BID-QID (for severe exacerbations or not responding to oral steroids) |
| **Antibiotics** |
| Indication: ≥2 of: 1) ↑ sputum production 2) ↑ sputum purulence 3) ↑ SOB<br>Simple exacerbation: Amoxicillin, 2nd/3rd gen Cephalosporin, Macrolide, Doxycycline or TMP/SMX<br>Complicated exacerbation: Fluoroquinolone or Amoxicillin/Clavulanate |
| **Ventilation** |
| NIPPV such as CPAP or BiPAP (in respiratory acidosis, severe dyspnea/distress) |
| **Intubation** |
| For life-threatening exacerbations, failed NIPPV, altered LOC, severe hypoxemia, cardiovascular instability, respiratory or cardiac arrest |

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 74. Am J Respir Crit Care Med 2013; 187(4):347-365.

# Myocardial Infarction

**Definition:** evidence of myocardial ischemia on the spectrum of ACS (unstable angina, NSTEMI and STEMI). Diagnosed by cardiac marker abnormalities and one of: ECG changes or HPI consistent with ACS.

## Differential Diagnosis

| |
|---|
| **Stable Angina** |
| Transient episodic chest discomfort secondary to myocardial ischemia<br>Precipitated by exertion or emotion, lasts <15 mins, relieved by rest or nitro |
| **Unstable Angina** |
| Angina with minimal exertion or at rest, new-onset angina, angina post MI/PCI/CABG, worsening change from baseline angina, increased duration of pain or threshold, or decreased response of previously effective angina meds |
| **NSTEMI** (non-occlusive) |
| Infarction without ST elevation (note: 25% NSTEMI have totally occluded artery) |
| **STEMI** (acute coronary occlusion) |
| **Infarction with primary ST elevation:** ≥1mm in 2 contiguous leads, except for V2-3 ≥1.5mm in females, ≥2mm in males over 40, and ≥2.5 in males under 40 -<br>**Other signs of occlusion:** hyperacute T waves, minor ST elevation with reciprocal ST depression, posterior MI (primary ST depression V1-4, often with 0.5mm STE on posterior leads), LBBB + Modified Sgarbossa, DeWinter sign |

## Assessment

History: character of pain, associated symptoms (diaphoresis, radiating pain, vomiting, and exertional pain have highest likelihood ratios for acute MI)
Classic Risk Factors: male, smoking, diabetes, HTN, FHx, dyslipidemia
Varied Presentations in: women, elderly, diabetics, dementia
Complications of AMI: arrhythmias, cardiogenic shock, papillary muscle rupture, pericarditis, stroke
Physical Exam: vitals, cardiac exam, resp exam, pulses, signs of complications

**Investigations:** ECG (ST-T changes, new BBB, pathological Q waves), CXR
Labs: CBC, lytes, cardiac enzymes

## Management

| |
|---|
| **General** |
| ABCs, monitors, oxygen, vitals, IV access<br>**Pain control:** NTG (avoid for RV infarcts) or Morphine if resistant to NTG |
| **ACEi, ß-blockers, Statins** |
| Atorvastatin 80mg PO in STEMI. Do NOT delay transfer to cath lab for statin<br>No role for initiating ACEi or ß-blocker in the ED<br>ACEi, ß-blocker + statins likely to be initiated during hospital admission (<24-48 hrs from time of presentation) |
| **Antiplatelet Therapy** |
| ASA 325mg chewed<br>Clopidogrel 300mg PO OR Ticagrelor 180mg PO (if going for primary PCI) |
| **Antithrombotic Therapy** |
| **Primary PCI:** UFH 4000 Units (max) then 12 U/kg/hr<br>**Fibrinolytics:** Enoxaparin or Fondaparinux IV bolus then SC dose daily |
| **Goals** |
| **Primary PCI:** within 90 mins of hospital arrival<br>**Lytics:** <12 hours of symptoms or cannot get to PCI centre within 120 mins, given within 30 mins of hospital arrival |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice - 8th ed, 2014; Chapter 78. Circulation 2013; 127:00-00. JACC 2022 Nov,80(20):1925-1960 (ACC Expert Consensus on Chest Pain in the ED).

# Congestive Heart Failure

**Etiology:** CAD, HTN, valve abnormalities, cardiomyopathy, infarction, pericardial disease, myocarditis, cardiac tamponade, metabolic disorders (i.e. hypothyroidism), toxins, congenital

## Precipitants of CHF Exacerbation

| Cardiac | Medications |
|---|---|
| Ischemia, dysrhythmias, mechanical complications (i.e. papillary muscle rupture) | Forgot meds, negative inotropes (CCB, ß-blocker), NSAIDs, steroids |
| **High Cardiac Output** | **Other** |
| Anemia, infection, pregnancy, hyperthyroidism | Lifestyle (high salt intake), renal failure, PE, HTN |

## Assessment

| Symptoms | Signs |
|---|---|
| **Left-sided:** SOB, PND, fatigue, orthopnea, angina, syncope, altered mental status, cough + wheeze (pulmonary congestion)<br>**Right-sided:** fatigue, abdominal distension, leg swelling, weight gain, nocturia | **General:** tachypnea, tachycardia, hypertension, hypotension, weak pulses<br>**Left-sided:** hypoxia, crackles, wheezes, S3 or S4<br>**Right-sided:** pitting edema, JVP elevation, hepatomegaly, ascites |

## Investigations

Labs: CBC, electrolytes, AST, ALT, BUN, Cr, Troponin, BNP (or NT-proBNP)
Tests: CXR, ECG, PoCUS (systolic function, pulmonary edema)

## Management

| General |
|---|
| ABCs, monitors, 100% $O_2$ non-rebreather facemask, vitals, IV access, position upright, +/- Foley catheter, treat precipitating factor<br>Morphine 1-2mg IV prn |
| **First-line** |
| Nitroglycerin 0.4mg sl q5min (if sBP>100) +/- topical nitroglycerin patch (0.2-0.8mg/h)<br>Furosemide: double home dose, 20mg IV if furosemide naive |
| **Second-line** |
| Double furosemide dose<br>**Think Sympathetic Crashing Acute Pulmonary Edema (SCAPE):** Nitroglycerin infusion if hypertensive (start 100µg/min & titrate)<br>**Think Cardiogenic Shock** if hypotensive (sBP<90): Norepinephrine 2-12µg/min or Dobutamine 2.5µg/kg/min |

Key References: Canadian Journal Cardiology 2007; 23(1): 21-45. Circulation 2009; 119: 1977-2016. Journal of Cardiac Failure 2010; 16(6): e134-156

# Cardiac Dysrhythmias

## Causes:

Enhanced Automaticity: MI, drugs, toxins, lyte imbalances
Triggered Activity: Torsades de Pointes, post-MI reperfusion
Re-entry: VT and SVT

## Main Classifications

| Bradydysrhythmias and AV Conduction Clocks |
|---|
| **1º =** prolonged PR interval<br>**2º (Mobitz I) =** gradual PR interval prolongation then QRS drop<br>**2º (Mobitz II) =** PR interval constant with QRS drop<br>**3º =** P wave and QRS complex unrelated, PP and RR intervals constant |
| **Supraventricular Tachydysrhythmias (Narrow QRS)** |
| **Regular rhythm:**<br>Atrial: sinus tachycardia, atrial tachycardia, atrial flutter<br>AV: SVT (AVNRT > AVRT), junctional tachycardia<br>**Irregular rhythm:**<br>Atrial: a fib, multifocal atrial tachycardia, SVT w/ aberrancy |
| **Ventricular Tachydysrhythmias (Wide QRS)** |
| **Regular rhythm:** Ventricular tachycardia, SVT w/ aberrancy<br>**Irregular rhythm:** Ventricular fibrillation, polymorphic VT, Afib w WPW |

## Assessment

Unstable Patient: altered mental status, respiratory distress, hypotension, syncope, chest pain with acute MI, signs of CHF, shock
Stable Patient: light-headedness, SOBOE, palpitations, mild anxiety

## Management

General: monitors, oxygen, continuous monitoring, IV access
Initial Approach: ABCs, treat symptomatic & unstable patients immediately
*See detailed **ACLS Algorithms**

| Bradycardia Algorithm |
|---|
| **1. Treat Reversible Causes:** O2 if hypoxia, Ca if hyperK, STEMI cath lab<br>**2. Treat Unstable Primary Bradyarrhythmia:** Atropine 0.5mg IV q3-5 mins +/- Dopamine 2-10µg/kg/min OR Epi 2-10µg/min<br>**If ineffective:** transcutaneous pacing, prepare for IV pacing<br>**Type II 2oAV block OR 3oAV block:** transcutaneous pacing |
| **Tachycardia Algorithm** |
| Synchronized cardioversion (with premedication) if unstable |
| **Atrial Fibrillation/Atrial Flutter** |
| 1. Treat secondary causes: sepsis, GI bleed, CHF, PE, EtOH withdrawal<br>2. Rate vs. Rhythm control |
| **VF/pVT** |
| Shock-CPR-pulse rhythm check cycles, Epinephrine 1mg IV q3-5mins, consider Amiodarone 300mg IV bolus with 2nd dose 150mg IV |
| **PEA/Asystole** |
| CPR, airway support, IV access, Epinephrine 1mg IV q3-5mins |

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 86+87. NEJM 2012; 366(23): 2198-2206. *BMJ* 2000; 320: 854-857.

# Pericarditis & Myocarditis

## Definitions

**Pericarditis:** Inflammation of the pericardial sac surrounding the heart
**Myocarditis:** Inflammation of the cardiac muscle

## Causes

| | |
|---|---|
| **Idiopathic** | Most common, often presumed viral |
| **Infectious** | Viral, bacterial including TB, fungal |
| **Post-injury** | Trauma, surgery, MI, radiation, aortic dissection |
| **Iatrogenic** | Post-vaccine, drugs |
| **Systemic disease** | Uremia, RA, SLE, scleroderma, malignancy |

## Assessment

History: **Pericarditis:** non-exertional, pleuritic pain, worse when supine and improves leaning forwards/sitting up, fevers, myalgias, dyspnea, diaphoresis, syncope or presyncope, recent viral illness. **Myocarditis:** presents mainly with CHF symptoms including dyspnea on exertion, bilateral leg swelling
Physical Exam: vitals (fever, BP, HR, RR), pericardial friction rub in pericarditis
Diagnosis of Pericarditis: ≥2 of: characteristic chest pain, friction rub, ECG changes, pericardial effusion (PCE) on ultrasound

## Investigations

| Pericarditis | Myocarditis |
|---|---|
| **Labs** | |
| ↑ CRP, ESR, WBC though not needed for diagnosis | Highly suggestive with elevated troponin, though negative troponin does not rule it out. |
| **ECG** | |
| Diffuse concave ST elevation II>III<br>PR depression, ST depression aVR only<br>**Note:** any Q wave, convex ST elevation, ST depression other than aVR or hyperacute T wave = acute coronary occlusion until proven otherwise | May have tachycardia/arrhythmia, conduction abnormality (PR, QRS, QT),Q wave, or ST/T changes<br>**Note:** can mimic STEMI, and myocarditis is diagnosis of exclusion |
| **Ultrasound** | |
| Used to identify the presence of a pericardial effusion | Reduced LVEF, global hypokinesis, regional wall motion abnormalities, may see PCE |
| **CXR** | |
| May see cardiomegaly if a pericardial effusion is present | |

## Management

| |
|---|
| **General** |
| Treat underlying cause |
| **Pericarditis** |
| Most can be managed as outpatient<br>**NSAID:** Ibuprofen 600mg PO TID (+ PPI) until symptom free, taper over 2-4 wks<br>**Colchicine** 0.6mg BID x 3 months (↓ risk of recurrence = NNT 5)<br>Steroids: autoimmune, uremic diseases (consult cardiology) |
| **Myocarditis** |
| Admission under cardiology<br>Supportive: treat arrhythmias and CHF symptoms<br>Complications: ventricular dysrhythmias, LV aneurism, CHF, dilated CM |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 72.
Tintinalli's Emergency Medicine – 9th ed, 2020. Chapter 55.

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# Deep Vein Thrombosis

**Definition:** formation of a blood clot in a deep vein, most commonly in the legs or pelvis

**Massive Ileofemoral DVT:** **Phlegmasia Alba Dolens (PAD)** or "painful white/milky leg": venous thrombosis progresses to massive DVT, but without ischemia as collateral veins are spared. **Phlegmasia Cerulea Dolens (PCD)** or "painful blue leg"**:** occurs following PAD when ischemia ensues, worsening congestion and edema, eventually progressing to gangrene

**Risk Factors:** venous stasis (surgery or trauma), vessel injury (surgery or trauma), hypercoagulability (inherited thrombophilia, active malignancy, pregnancy, OCPs, prior PE/DVT)

**Differential Diagnosis:** chronic venous insufficiency, cellulitis, muscle strain/tear, Baker's cyst, hematoma, claudication/ischemia, intra-abdominal compression, unrecognized trauma

## Assessment

Hallmarks of DVT include unilateral erythema, swelling, warmth and limb tenderness (especially with palpation of posterior calf and popliteal fossa)

| **Modified Wells Criteria for DVT** | |
|---|---|
| **+1** Active malignancy (treatment within 6 months or palliative) | |
| **+1** Paralysis, paresis, or recent immobilization of lower limb | |
| **+1** Bedridden >3 days or major surgery in last 12 weeks | |
| **+1** Tenderness along deep venous system | |
| **+1** Entire leg swollen | |
| **+1** Calf swelling >3cm compared to asymptomatic side | |
| **+1** Pitting edema in symptomatic leg | |
| **+1** Superficial non-varicose veins | |
| **+1** Previous DVT | |
| **-2** Alternative diagnosis as or more likely than DVT | |
| **Interpretation and Further Workup** | |
| **DVT unlikely (low risk)**<br>Score <2 | Order D-Dimer:<br>If negative (<500) = no DVT<br>If positive (≥500) = obtain leg Doppler US |
| **DVT likely (high risk)**<br>Score ≥2 | Obtain leg Doppler US ± D-dimer*<br>*D-dimer still useful in case of negative US, as negative US with positive dimer in this sub-group warrants repeat US to ensure below knee clot has not progressed to above knee |

**Investigations:** CBC, BUN, Cr, electrolytes, D-dimer, INR/PTT
Leg doppler – standard 3-point compression tests

## Management

| **DVT** |
|---|
| **Preferred Outpatient Therapy:** DOACs (Apixaban 10mg BID x7 days then 5mg BID or Rivaroxaban 15mg BID x3 weeks then 20mg daily) |
| **DVT + Cancer or Pregnancy:** LMWH (Enoxaparin 1mg/kg SC) |
| **Renal Impairment:** Unfractionated Heparin 70-80 U/kg |
| Consult Thrombosis for outpatient management |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 88. J Thromb Haemost 2008; 6:772-80. NEJM 2003; 349(13):1227-35.

# Pulmonary Embolism

**Definition:** results most commonly after a clot formed hours-weeks earlier in deep veins of leg dislodges and travels through venous system into right ventricle and then into pulmonary vasculature. Occasionally, a clot originates spontaneously in pulmonary vasculature

**Risk Factors:** see DVT risk factors above

**Differential Diagnosis:** ACS, costochondritis, rib fracture, spontaneous pneumothorax, pneumonia, pericarditis, COPD/asthma

## Assessment

Hallmark symptoms include sudden onset of dyspnea and pleuritic chest pain

**Massive PE:** hypotension, cardiac arrest, bradycardia (HR <40) with shock

**Submassive PE:** no hypotension, evidence of RV strain (on POCUS, CT or elevated BNP, ECG changes), or myocardial necrosis (elevated troponin)

| Wells Criteria for PE | Interpreting Wells Criteria | |
|---|---|---|
| **+3** Signs + symptoms of DVT<br>**+3** PE = #1 diagnosis<br>**+1.5** HR >100<br>**+1.5** Immobilization ≥3 days OR surgery in past 4 weeks<br>**+1.5** Hx DVT/PE<br>**+1** Hemoptysis<br>**+1** Active cancer (treatment within 6 months or palliative) | **Two-Tier**<br>Low: ≤4<br>High: >4 | **PE unlikely**<br>Order D-Dimer:<br>**If negative**<br>(<500) = no PE<br>**If positive**<br>(≥500) = CTPA<br><br>**PE likely**<br>Obtain CTPA |
| **PERC (PE Rule-out Criteria)** | **Age-Adjusted** | |
| Essentially rules out PE (i.e. <2% chance of PE) if **PERC Negative** (NO high-risk features below) and low pre-test probability.<br><br>**High-Risk Features:**<br>Age≥50, HR≥100, SpO2<95%, hemoptysis, hormone use, recent (≤4 weeks) surgery/trauma, prior PE/DVT or unilateral leg swelling<br><br>If PERC positive, apply Wells | D-dimer levels rise naturally with age, even in otherwise healthy patients.<br><br>For patients >50, **Age x 10** validated as safe D-dimer cut-off.<br><br>For example, for a 62-year-old patient, 620 (62 x 10) is validated as the D-dimer threshold. Therefore D-dimer <620 rules out PE. | |
| **ECG Signs of Acute RV Strain** | **YEARS Algorithm** | |
| Heart rate/rhythm: sinus tach, new A fib<br>Electrical conduction: new RBBB<br>Axis: new right axis, or S1<br>ST/T changes: primary T wave inversion anterior and inferior, S1Q3T3 | Simplifies Wells score into 3 features most predictive of PE:<br>1. Clinical signs of DVT<br>2. Hemoptysis<br>3. PE as most likely diagnosis<br>**0 YEARS** items: D-dimer threshold **<1,000** excludes PE<br>**≥1 YEARS** item: D-dimer **<500** required to exclude PE | |

## Management

| PE |
|---|
| See DVT management above; tPA reserved for massive PE (50mg IV over 20 minutes, followed by another 50mg IV if no improvement) |

**EMOttawa Blog Posts:** PE in Pregnancy, D-Dimer in PE

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2017; Chapter 78. JAMA 2014;311(11):1117-1124. Lancet 2017; 390(10091):289-297.

# Gastrointestinal Bleeding

**Risk Factors:** medications (NSAIDs, anticoagulants), excessive vomiting, bleeding disorders, malignancy, alcohol use, ulcer history, H. pylori

## Differential Diagnosis

| Upper GI bleed (proximal to Ligament of Treitz) |
|---|
| Peptic ulcer disease (gastric > duodenal) |
| Gastritis/esophagitis |
| Esophageal varices |
| Mallory-Weiss tears |
| Gastric cancer |
| **Lower GI bleed (distal to Ligament of Treitz)** |
| Colitis (inflammatory, infectious, ischemic) |
| Anorectal pathology (hemorrhoids, fissures, proctitis) |
| Angiodysplasia |
| Diverticulosis |
| Malignancy |

## Assessment

History: blood quantity/quality, symptoms of anemia (fatigue, SOB, chest pain), Hx liver disease, medication review, smoking/EtOH, bleeding disorders, constitutional symptoms
Beware mimics: Pepto-Bismol, iron ingestion can cause dark stools
UGIB: hematemesis, coffee ground emesis, melena, BRBPR if brisk UGIB
LGIB: hematochezia, BRBPR
Physical Exam: ABCs, vitals, inspect nasal-oral cavity, abdominal exam, DRE

## Investigations

Labs: CBC, lytes, INR/PTT, BUN, Cr, lactate, VBG, T+S/T+C
Tests: ECG, CXR +/- CT if indicated for LGIB

## Management

| General |
|---|
| ABCs, monitors, oxygen, vitals, 2 large bore IVs, reverse any anticoagulation, GI consult |
| Intubate early if suspect unprotected airway or risk of aspiration |
| Transfusion threshold: Hb <70, Plt <50, or hemodynamically unstable or with active bleeding |
| **UGI Bleed** |
| Pantoloc 80mg IV bolus then 8mg/h infusion (or intermittent BID dosing) |
| Octreotide 50µg IV bolus then 50µg/h infusion – for suspected variceal bleeding |
| Ceftriaxone 2g IV: for suspected variceal bleeds, prevention of SBP |
| Tranexamic acid: hemodynamically unstable patients (no clear evidence) |
| Balloon tamponade: crashing GI bleeding patient |
| **LGI Bleed** |
| NPO, IV fluids, manage underlying etiology (i.e. Abx, steroids) |
| Colonoscopy to evaluate cause of bleeding |

**EMOttawa Blog Posts:** Upper GI Bleeds, Podcast

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 30.

# Stroke

## Common Syndromes

| ACA Stroke |
|---|
| Contralateral motor + sensory deficits (Leg > face/arm)<br>Bowel and bladder incontinence<br>Impaired judgement/insight |
| **MCA Stroke** |
| Contralateral motor + sensory deficits (Face/arm > leg)<br>Contralateral hemianopsia; gaze preference towards lesion<br>Aphasia (dominant) or neglect (non-dominant) |
| **PICA Stroke (Wallenberg Syndrome)** |
| Pain/temperature loss on contralateral side + ipsilateral face<br>Ipsilateral Horner's-like syndrome<br>"Deadly Ds": dysphagia, diplopia, dysarthria, dysphonia |

## Assessment

History: time of onset (usually abrupt), LOC (usually normal or non-significant decrease), focal symptoms, headache (pain more suggestive of hemorrhagic stroke or dissection), functional baseline (dictates treatment)
Stroke Mimics: seizure, migraine, syncope, metabolic derangements, sepsis, tumor, functional neurological disorder (conversion disorder), seizure (i.e. Todd's paralysis)
Physical Exam: vitals (close attention to BP), neuro (NIHSS scale), cardiovascular exam (dissection, arrhythmias, valvular pathology), look for comorbidities

## Investigations

**Labs:** CBC, lytes, extended lytes, glucose, BUN, Cr, INR, PTT
**ECG:** rule out Afib
**Neuroimaging:** acute stroke protocol (CT/CTA immediately)

## Management

| General |
|---|
| ABCs, monitors, oxygen, vitals, IV access +/- intubation (declining GCS, evolving symptoms, or presumed hemorrhagic transformation)<br>**BP control:** lower if HTN severe (>220/120), BP <185/110 if giving tPA<br>**Consult neurology,** admission to stroke unit |
| **Antiplatelet Therapy** |
| Don't give acutely, start ASA +/- Clopidogrel daily once discharged |
| **Stroke Time Windows** (consult FAST-ED app) |
| **<4.5 hrs:** tPA 0.9mg/kg (max 90mg, 10% bolus, 90% over 1 hr)<br>**<6-24 hrs:** Endovascular Therapy (EVT) for large vessel occlusion (i.e. carotid, MCA, basilar)<br>Discuss with stroke team |
| **Stroke Prevention** |
| **Primary:** stratify based on $CHADS_2$ (stroke risk with Afib), Ottawa TIA Risk Score, prescribe ASA vs. DOACs<br>**Secondary:** 28 days of ASA + Clopidogrel in minor stroke (NIHSS 0-3), oral anticoagulation started 1-2 weeks post-stroke if Afib, ASA otherwise |

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 101. NEJM 1995; 333:1581-1588. AMJ Neuroradiol 2001; 22:1534-1542. Int J Stroke 2020; 15(6): 689-698. NEJM 2018; 378(1):11-21. NEJM 2018; 378: 708-718.

# Transient Ischemic Attack

## Definitions

| TIA Definition (Canadian Stroke Best Practices) |
|---|
| A brief episode of neurological dysfunction caused by focal brain, spinal cord or retinal ischemia without imaging evidence of acute infarction, typically resolving within one hour. |
| **Very High-Risk TIA** |
| All TIAs with symptom onset **within 48 hours** |
| **High-Risk TIA** |
| Symptom onset **between 48 hours and 2 weeks** with the following symptoms:<br>Motor or speech disturbance |
| **Moderate-Risk TIAs** |
| Symptom onset **between 48 hours and 2 weeks** with the following symptoms:<br>Sensory loss, vision loss<br>Posterior circulation stroke: binocular diplopia, dysarthria, dysphagia, ataxia |
| **Low-Risk TIAs** |
| All TIAs with symptom onset **greater than 2 weeks** |

## Assessment

History: time of onset, differentiate between motor, speech, vision disturbances and posterior circulation symptoms
Physical Exam: vitals, neuro exam, cardiovascular exam (dissection, arrhythmias, valvular pathology), look for comorbidities

## Investigations

**Labs:** CBC, lytes, extended lytes, glucose, BUN, Cr, INR, PTT
**ECG:** rule out Afib
**Neuroimaging:** all TIAs (non-contrast CT head in ED), moderate-risk (±CTA head & neck), high- to very high-risk (+ CTA head & neck)

## Management

| General |
|---|
| ABCs, monitors, oxygen, vitals, IV access |
| **High-Risk TIA features** |
| Loading dose: Clopidogrel 300mg PO + ASA 160mg PO<br>Dual antiplatelet therapy: Clopidogrel 75mg PO + ASA 81mg PO daily x 21-28 days<br>Monotherapy (after 21 days): ASA 81mg PO daily |
| **Low-Risk TIA features** |
| ASA 81mg PO daily |
| **Disposition** |
| Stroke clinic follow-up within 3 weeks<br>Risk stratification: $CHADS_2$ (stroke risk with Afib), Ottawa TIA Risk Score<br>Outpatient carotid dopplers or CT angiogram +/- endarterectomy |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 101. Canadian Stroke Best Practices, 2018. Stroke 2018; 49:2278-2279. Int J Stroke. 2019; 14(7) 756-751.

# Wound Management

## Definitions:

**Primary Closure:** closure immediately (via sutures or staples)
- Leads to faster healing and best cosmetic result
- Best for wounds within 8 hrs of presentation or face wounds within 24 hrs

**Secondary Closure:** wound heals naturally, without surgical closure
- Best for small partial thickness avulsions or fingertip amputations.

**Delayed/Tertiary Closure:** initial wound cleansing/dressing followed by packing, then primary closure after 72 hrs
- Best when patients present late (>24 hrs) or contaminated crush wounds

**Closure Techniques:** simple interrupted/running suture is most common method of closure in the ED. Other methods include: staples; horizontal mattress; hair apposition (all good for scalp lacs) and vertical mattress (gaping, deep wounds); tape or glue.

## Assessment

### Suture Types:

| **Absorbable** | **Non-Absorbable** (more common in ED) |
|---|---|
| **Braided:**<br>• Vicryl<br>• Vicryl Rapide<br>**Monofilament:**<br>• Monocryl<br>• Fast absorbing gut<br>• Chromic gut | **Braided:**<br>• Ethibond<br>• Silk<br>**Monofilament:**<br>• Ethilon (Nylon) |

### Wound Preparation:

1) Debridement 2) Wound Cleansing 3) Irrigation

### Suture Sizes:

**3**-0 sutures on **Three** places: chest, abdomen, back
**4**-0 sutures on **Four** extremities: arms and legs
**5**-0 sutures where you have **Five** fingers: hands
**6**-0 sutures **(S)ensitive** areas: face, genitals

### Timing of Removal:

Face: 3-5 days
Scalp & arms: 7-10 days
Tunk, legs & dorsal hands/feet: 10-14 days
Palms & soles: 14-21 days

## Management

| | |
|---|---|
| **Antibiotic Prophylaxis** | Indicated in gross contamination, severe crush injuries, open fractures, wounds involving joints (including MCP, i.e. "fight bites") or cat bites, intra-oral lacs, immunocompromised (DM, CKD, chronic steroid use)<br>Ideal Abx: Keflex or Clavulin (bites) |
| **Tetanus Prophylaxis** | Give DTaP booster unless last booster was within 10 yrs<br>Given ASAP but can be given days-weeks following injury |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2017; Chapter 52. Emerg Med Clin N Am 2007; 25:23-39.

# Diabetic Emergencies

## Definitions

| DKA | HHS |
|---|---|
| Predominantly Type 1 DM<br>Insulin deficiency + stressor → counter-regulatory hormone excess → ↑ lipolysis (ketoacidosis) and osmotic diuresis (dehydration)<br>**Serum glucose:** >16 mmol/L<br>**Other labs:** $HCO_3$<15, pH <7.3<br>**Onset:** hours to days<br>**Features:** dehydration, often young | Predominantly Type 2 DM<br>Relative insulin deficiency + stressor → counter-regulatory hormone excess → osmotic diuresis (dehydration)<br>**Serum glucose:** >30 mmol/L<br>**Onset:** days to weeks<br>**Features:** severe dehydration, hyper-osmolality, often elderly with AMS |
| **Stressor (7 Is):** Infection, Infarction, Intoxication, Insulin (dose changed/missed), Incision (surgery), Initial (diagnosis), Impregnated | |

## Assessment

History: N/V, abdominal pain, polyuria/polydipsia, weakness, anorexia
Physical Exam: rapid, deep breathing (Kussmaul) respirations, tachycardia, ileus, acetone breath

## Investigations

**Labs:** glucose, urine/serum ketones, ß-hydroxybutyrate, CBC, lytes, extended lytes, glucose, BUN, Cr, VBG, lactate +/- cultures, ß-HCG, cardiac enzymes (if indicated)

## Management

**Fluid Resuscitation**

NS 1-2 L over 1 hours
Change to D5½NS when BG <16

**Insulin**

Short acting insulin Regular
Infusion of 0.1 U/kg/h (goal = lower BG by 4-5)
**Once gap closed:** continue infusion x 1 hr but overlap + switch to SC insulin

**Electrolyte Replacement**

**Potassium**
- K <3.3 mmol/L: hold insulin and give 40mmol/L KCl
- K 3.3-5 mmol/L: give 20-30mmol/L KCl
- K >5 mmol/L: re-check K in 1-2 hours

**Phosphate:** Low phosphate can be replaced if severe levels or metabolic disturbances (muscle weakness, paralysis, rhabdomyolysis)
**Sodium:** Pseudohyponatremia common due to dilutional decrease

**Disposition**

**Admission if:** first time presentation, comorbidities, unable to close gap, iatrogenic complications (ARDS, cerebral edema, fluid overload), or DKA/HHS due to stressors listed above (i.e. need to manage MI or sepsis in hospital)
**Education:** diet, insulin administration, fluid replacement

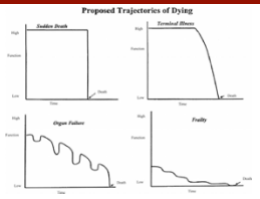
EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 118.

# End-of-Life Care

## Trajectories of Dying:

**Sudden death** (15%): i.e. cardiac arrest, trauma
**Terminal illness** (30%): predictable decline in 6 months or less i.e. cancer or terminal AIDs
**Organ failure** (30%): gradual decline with intermittent exacerbations i.e. COPD, CHF
**Frailty** (30%): gradual decline, lingering course over many years i.e. dementia




## Palliative Performance Scale (PPS) & Eastern Cooperative Oncology Group (ECOG) Performance Status:

| | |
|---|---|
| **Stable** | PPS 70-100% |
| **Transitional** | PPS 40-60% |
| **End-of-Life** | PPS <30%, bedbound |
| **Grade** | **ECOG** |
| 0 | No restrictions, able to carry on pre-disease performance |
| 1 | Restricted physically strenuous activity, able to carry out light/sedentary work |
| 2 | Ambulatory, able to carry out self-care, unable to carry out working activities, up >50% waking hours |
| 3 | Capable of only limited self-care, confined to bed/chair >50% waking hours |
| 4 | Completely disabled, cannot carry out self-care, totally confined to bed/chair |
| 5 | Death |

## Investigations

Consider discontinuation of cardiac monitoring, vital signs and bloodwork and minimization of IV fluids. Given presenting symptoms of the patient and their goals of care, further investigations are at times appropriate. Discontinue only meds and devices (i.e. catheters, NG tubes) not contributing to patient comfort.

## Symptom Management

| | |
|---|---|
| **Agitation/ Delirium** | **Haloperidol** 0.5mg-1mg SC/IV q2h PRN<br>- if severe add **Methotrimeprazine** 12.5-25mg SC q4h PRN<br>- if severe add **Midazolam** 0.5-1mg SC/IV q30min PRN |
| **Pain/ Dyspnea** | **Opioid Naive:** SC route preferred over IV (due to longer $t_{1/2}$)<br>- **Morphine** 1-2mg SC/IV q30min PRN OR<br>- **Hydromorphone** 0.2-0.4mg SC/IV q30min PRN<br>If patient on regular oral opioid medication, convert current regime to SC dosing:<br>**Morphine:** 10mg (PO) = 5mg (SC/IV) *equals*<br>**Hydromorphone:** 2mg (PO) = 1mg (SC/IV)<br>**O2 -** if hypoxic or for patient's comfort<br>**Fan blowing** – improves patient comfort |
| **Secretions** | Re-position, reassure family that secretions not causing distress<br>**Glycopyrrolate** 0.4mg SC/IV q4h PRN |
| **Nausea/ Vomiting** | **Metoclopramide** 5-10mg SC/IV q4h PRN (contraindicated in bowel obstruction) OR<br>**Haloperidol** 0.5-1mg SC/IV q4h PRN |

**EMOttawa Blog Posts:** Palliative Care Part 1, Part 2, GOC Discussion

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2017; Chapter e9. J Palliat Med 2018. 21(11):1651-1661. J Palliat Care. 1996; 12(1):5-11. CJEM 2020 22(5) 626-628.

# Sepsis

## Definitions

| Sepsis | |
|---|---|
| Life threatening organ dysfunction caused by a dysregulated host response to infection with a qSOFA score ≥ 2 | |
| **Septic Shock** | |
| Vasopressor requirement to maintain a MAP ≥65<br>Serum lactate ≥2mmol/L in the absence of hypovolemia | |
| **Clinical tools to aid in sepsis recognition** | |
| **SIRS** | 2 or more of:<br>T <36 or >38.3 \| HR >90 \| RR >20 or $CO_2$ <32 \| WBC <4 or >12 |
| **qSOFA** | 2 or more of:<br>GCS <15 \| RR ≥22 \| sBP <100 |

## Assessment

History: associated symptoms, full review of systems, comorbidities
Physical Exam: vitals, volume status, look for a focus (respiratory, urine, abdomen, skin, blood, brain, permanent lines)

## Investigations

Full Septic Workup: CBC, lytes, extended lytes, BUN, Cr, LFTs, VBG, lactate, INR/PTT, blood C+S, urine C+S, ECG, CXR
RUSH Exam: heart (PSL, 4 chamber), IVC view, Morrison's and splenorenal views, bladder window, aorta, pneumothorax

## Management

| General |
|---|
| Monitors, oxygen, vitals, 2 large bore IVs<br>Early antibiotics (within 1 hour), crystalloids (RL > NS)<br>Endpoints: MAP >65, capillary refill time, lactate clearance, urine output |
| **Resuscitation** |
| **Crystalloids:** Ringer's Lactate for patients with hypotension or lactate ≥4<br>**Vasopressors:** Norepinephrine 5-10µg/min (if not fluid responsive), Vasopressin 0.04 U/min (if moderate doses of NE being used)<br>**Steroids:** if refractory to fluids + pressors or on chronic steroids |
| **Antibiotics** |
| Empiric treatment: Pip-Tazo 3.375g IV +/- Vancomycin 1-1.5g IV<br>Respiratory: Ceftriaxone 2g IV + Azithromycin 500mg IV<br>Urinary: Ceftriaxone 2g IV + Tobramycin 3-5mg/kg (single dose)<br>Meningitic doses: Ceftriaxone 2g IV + Vancomycin 2g IV + Dexamethasone 10mg IV (within 1 hr of Abx) +/- Acyclovir 1g IV (for HSV encephalitis) |
| **Disposition** |
| Admission to medicine +/- ICU (if requiring vasopressors or intubated) |

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice - 8th ed, 2014; Chapter 6. NEJM 2001; 345(19): 1368-77. JAMA 2016; 315(8): 801-10. Crit Care Med 2017; 45(3): 486-552. JAMA 2019; 321(7): 654-664. AJRCCM 2019; 199(9): 1097-1105.

# Acid-Base Disorders

## Etiology of Acid-Base Disorders

| | | |
|---|---|---|
| **Respiratory Acidosis (Acute)** | Airway obstruction<br>Pulmonary disease<br>Thoracic trauma | CNS depression<br>Neuromuscular disorders<br>Toxicologic (opioid OD) |
| **Respiratory Alkalosis** | Hyperventilation<br>Panic attack<br>Pulmonary disease<br>Hyperthyroidism | Pregnancy<br>Sepsis<br>Sympathomimetics<br>Salicylate toxicity |
| **Elevated Anion Gap Metabolic Acidosis (CATMUDPILES)** | **C**O poisoning<br>**A**minoglycosides<br>**T**heophylline<br>**M**ethanol<br>**U**remia<br>**D**KA | **P**araldehyde<br>**I**ron, **I**soniazid<br>**L**actic acidosis<br>**E**thanol, **E**thylene glycol<br>**S**alicylate toxicity |
| **Normal Anion Gap Metabolic Acidosis (HARDUP)** | **H**yperalimentation<br>**A**cetazolamide use<br>**R**enal tubular acidosis | **D**iarrhea<br>**U**retero-enteric fistula<br>**P**ancreatic fistula |
| **Metabolic Alkalosis** | Vomiting, NG suction<br>Diuretics<br>Massive transfusion | Hyperaldosteronism<br>Hypercortisolemia<br>Hypoalbuminemia<br>Hypercalcemia |

## Investigations

Labs: CBC, Cr, lytes, extended lytes, TSH, VBG, lactate, tox screen. For suspected: DKA/AKA, add add B-hydroxybutyrate; ASA overdose, add salicylate level; ingestion, add toxic alcohol screen

Imaging: Consider based on type of acid-base disturbance and suspected cause, i.e. CXR for suspected pulmonary disease

| Disorder | pH | $PCO_2$ | $HCO_3^-$ | Expected Compensation* |
|---|---|---|---|---|
| Resp. Acidosis | ↓ | ↑ | ↑ | ↑ $HCO_3^-$ = 0.1 $\Delta Pco_2$ (acute)<br>↑ $HCO_3^-$ = 0.4 $\Delta Pco_2$ (chronic) |
| Resp. Alkalosis | ↑ | ↓ | ↓ | ↓ $HCO_3^-$ = 0.2 $\Delta Pco_2$ (acute)<br>↓ $HCO_3^-$ = 0.5 $\Delta Pco_2$ (chronic) |
| Metab. Acidosis | ↓ | ↓ | ↓ | ↓ $Pco_2$ = ~1 $\Delta HCO_3^-$ |
| Metab. Alkalosis | ↑ | ↑ | ↑ | ↑ $Pco_2$ = ~1 $\Delta HCO_3^-$ |

*Inappropriate compensation indicates a second acid-base disorder

Anion Gap: Na – ($Cl^-$ + $HCO_3^-$); Normal AG = 8 – 12; ↑ likely metabolic acidosis
If metabolic acidosis is present, calculate a delta gap and use Winter's formula
Winter's Formula: pCO2 = 1.5HCO3 + 8 +/-2 (for metabolic acidosis)

## Management

| |
|---|
| **Acute Respiratory Acidosis = $PCO_2$ > 40 mm Hg, pH < 7.35** |
| Relieve airway obstruction, treat underlying cause, supplemental $O_2$ if hypoxic<br>Non-invasive or mechanical ventilation as needed |
| **Respiratory Alkalosis = $PCO_2$ < 38 mm Hg, pH > 7.45** |
| Find and treat underlying cause |
| **Metabolic Acidosis = $HCO_3^-$ < 24 mmol/L, pH < 7.35** |
| Find and treat underlying cause |
| **Metabolic Alkalosis = $HCO_3^-$ > 40 mmol/L, pH > 7.45** |
| Rarely causes dangerous alkalemia. Find and treat underlying cause |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 116.

# ENT Emergencies - Vertigo

## Important Causes

| Benign Paroxysmal Positional Vertigo (BPPV) |
|---|
| Short lived (20-30 secs) vertigo brought on by lying down, turning over or getting out of bed. Resolves when still. **No spontaneous nystagmus.** |
| **Vestibular Neuritis** |
| Hours or days of constant severe vertigo, worse with head movements. Difficult with gait. **Spontaneous or gaze evoked nystagmus** in first few days. Resolves over a few weeks. |
| **Posterior Circulation Stroke** |
| **Can present similar to vestibular neuritis.** May have focal paresthesia, weakness, headache or neck pain, and Deadly Ds: dysarthria, diplopia, dysmetria, dysphonia, dysphagia. |
| **Vestibular Migraine** |
| **Often under-diagnosed.** Multiple episodes of dizziness lasting minutes to days. History of migraines. Half of the episodes have either typical migraine headache, and/or associated photophobia/phonophobia. |

**Other less common causes:** Meniere's, Multiple Sclerosis, labyrinthitis, other central causes (cerebellar hemorrhage, PICA stroke, head trauma)

## Assessment

Positional Testing (Dix-Hallpike or Roll Test): if short episodes initiated with head movement and without spontaneous or gaze evoked nystagmus
HINTS Exam: if constant vertigo and nystagmus present
Central Cause: neuro exam, gait and coordination exam

| Dix-Hallpike Test (diagnose posterior-canal BPPV) |
|---|
| Head turned 45° to one side while patient sitting. Patient moved to supine position with head hanging over edge of bed. Observe for vertical upward or rotatory nystagmus. Repeat with patient looking 45° in other direction. |
| **Roll Test (diagnose horizontal-canal BPPV)** |
| Patient initially supine, head on bed. Turn head 90 ° to one side, observe for horizontal nystagmus. Both sides will show horizontal nystagmus. |
| **HINTS Exam (differentiate vestibular neuritis vs. posterior stroke)** |
| **Must have all three to be diagnosed vestibular neuritis:**<br>**Head Impulse:** corrective saccade as examiner turns head away from direction of spontaneous nystagmus<br>**Nystagmus:** unidirectional horizontal/rotatory nystagmus<br>**Test of Skew:** no vertical or slanted eye movements on cover-uncover test |

## Management

| Peripheral |
|---|
| Epley's Maneuver for PC BPPV, Gufoni for HC BPPV<br>Consider steroids for vestibular neuritis (evidence poor) |
| **Central** |
| Neuroimaging, neuro consult +/- stroke management |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 19.

# ENT Emergencies

## Epistaxis

**Causes:** trauma (nasal, digital, facial), URI, allergies, low humidity, polyps, foreign body, idiopathic causes (familial), systemic causes (atherosclerosis, anticoagulation, pregnancy, coagulopathies, diabetes, liver disease)

**Assessment:** visualize nares + oropharynx for active bleeding

**Labs:** CBC, INR/PTT +/- cross+type

### Management

| General |
|---|
| ABCs, vitals, volume assessment<br>**Initial step:** compress cartilaginous part of nose x 20 mins<br>**Next step:** compress with Lidocaine/Epinephrine/decongestant-soaked pledget +/- topical TXA<br>+/- Silver nitrate if able to identify site |
| **Anterior Bleeds (90% Little's area/Kesselbach's plexus)** |
| Anterior packing: nasal tampon, rhino rockets or Vaseline gauze pack<br>Apply anterior pack to active side first, if ineffective, pack both nares |
| **Posterior Bleeds** |
| Epistat or Foley catheter. Apply traction once inserted.<br>Keflex x 5 day course or until pack removal to prevent TSS |

## Pharyngitis

**Etiology:** viruses (rhinovirus, adenovirus), bacterial (Group A Strep)

### Assessment

History: odynophagia, URI symptoms, complications are rare (ie. rheumatic fever)

Physical Exam: vitals, ABCs, red flags

| Can't Miss Diagnoses |
|---|
| **Peritonsillar abscess:** muffled voice, uvular deviation |
| **Retropharyngeal abscess:** drooling, airway compromise |
| **Tracheitis:** may be confused with croup, stridor, labored breathing |
| **Epiglottitis:** fever, stridor, rapidly progressive swelling |

| Modified Centor Criteria | |
|---|---|
| **Age** | **Tonsillar exudates = +1** |
| 3-14 years old = **+1** | **Tender anterior cervical lymph nodes = +1** |
| 15-44 years old = **0** | **Temp >38°C = +1** |
| >44 years old = **-1** | **Absent cough = +1** |

**Management:** fluids, antipyretics, single dose Dexamethasone may reduce pain/duration.

Antibiotics reduce symptoms by 16 hours. They do NOT reduce incidence of suppurative complications.

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 23+72.

# Electrolyte Disturbances

**History:** review of systems, neurologic symptoms (headache, lethargy, weakness, muscle cramps, ↓ LOC, personality changes, seizures), comorbidities, infection, intake + losses, past history of electrolyte disturbances

## Hyperkalemia: [K] >5.5 mmol/L

| Causes |
|---|
| Pseudohyperkalemia (#1), chronic renal failure, acute acidosis, medications* (ACEi, NSAIDs, K-sparing diuretics, Digoxin, Septra), cell death (rhabdo, burn/crush injuries, hemolysis, tumour lysis syndrome) |
| **ECG Changes** |
| Rate (brady, junctional), conduction (wide PR/QRS), axis change, peaked Ts |
| **Management** |
| **Protect:** 1 amp CaCl or 3 amps Ca gluconate (*if ECG changes noted)<br>**Shift:** 1-2 amps D50W + 10 U regular insulin, albuterol nebs +/- bicarbonate (if acidotic)<br>**Excrete:** fluids, Lasix, PEG3350 +/- dialysis if critical K or unable to excrete |

## Hypokalemia: [K] <3.5 mmol/L

| Causes |
|---|
| Renal losses (diuretics), non-renal losses (vomiting, diarrhea), metabolic alkalosis |
| **ECG Changes** |
| Rhythm (ectopy, TdP), conduction (U wave), Diffuse ST depression, flat/inverted T |
| **Management** |
| Replace: KCl 10-20mmol/hr IV or KCl 40-60mmol PO q2-4hrs<br>HypoMg: $MgSO_4$ 500mg/h IV to ensure K being driven into cells |

## Hyponatremia: [Na] <135 mmol/L

| Causes |
|---|
| Hypo-osmolar most common - hypervolemic (CHF, cirrhosis, nephrotic syndrome), euvolemic (SIADH), hypovolemic (adrenal insufficiency, vomiting, diarrhea, diuretics, poor PO fluid intake) |
| **Management** |
| Known acute (<24-48 hrs) [Na]<120 or symptomatic (↓ LOC, focal neurological symptoms): max Na 8mmol/L in 24 h to prevent central pontine myelinolysis<br>**Dose option:** IV 3% saline 100cc IV over 10 mins (if seizing) |

## Hypercalcemia: [Ca] >2.6 (corrected for albumin)

| Causes |
|---|
| Malignancy (breast, lung, kidney, multiple myeloma), hyperPTH, granulomatous diseases, meds (thiazides, Li, estrogen, vitamin A/D toxicity) |
| **ECG Changes** |
| Short QT, ST elevation, bradyarrhythmias, AV block |
| **Management** |
| Bolus NS until normal perfusion, then infusion to 200cc/hr with goal of urine output 2L/day. Lasix to promote diuresis, bisphosphonates and calcitonin. |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 117.

# Urologic Emergencies

## Renal Colic

**Risk Factors:** hereditary (RTA, G6PD deficiency, cystinuria, oxaluria), lifestyle (minimal fluid intake, excess vit C, oxalation, purines, calcium), meds (loop diuretics, acetazolamide, topiramate), medical conditions (UTI, IBD, gout, DM, hypercalcemia), obesity

### Assessment

History: unilateral flank pain +/- radiating to groin, "writhing" in pain, N/V, trigonal irritation (frequency, urgency)

Physical Exam: vitals (fever, HR, RR), abdominal exam, CVA tenderness

**Investigations:** CBC, urinalysis, β-hCG (females)

| **CT** |
|---|
| Vast majority do NOT need CT imaging<br>**Relative indications:** first presentation of renal colic, complicated renal colic, elderly patients, suspicion of a serious alternative diagnosis |
| **Ultrasound** 🔍 |
| Most helpful in detecting hydronephrosis (98% sensitivity) |
| **KUB** |
| Plain X-rays are neither sensitive nor specific for detection of renal stones. KUB may be used to follow stone progression. |

### Management

| | |
|---|---|
| **General** | IV NS if clinically dehydrated |
| **N/V** | Zofran 4-8mg IV |
| **Analgesia** | Morphine 6mg IV + Ketorolac 30mg IM/IV or Naproxen 500mg PO |
| **MET** | Tamsulosin 0.4mg PO OD x3 weeks (large stone >4mm or distal stones) |
| **Disposition** | Can be safely discharge with appropriate GP/urology follow-up |
| **Urology consult** | Intractable pain, infected stone, compromised renal function (single kidney, transplanted kidney, bilateral obstruction) |

## UTI and Pyelonephritis

**Causes:** E. coli (85%), Klebsiella, Proteus, Saprophyticus

### Assessment

History: UTI (frequency, urgency, dysuria, hematuria), pyelo (fever/chills, flank pain, N/V), associated vaginitis/cervicitis symptoms, sexual history

**Investigations:** urine dipstick, urine R+M, urine C+S +/- CBC, BUN, Cr

### Management

| **Uncomplicated UTI** |
|---|
| Septra DS PO BID x 3 days<br>Macrobid 100mg BID x 5 days<br>If suspected STI: Levofloxacin 500mg PO daily x 7d + CTX 250mg IM x1 |
| **Complicated UTI/Uncomplicated Pyelonephritis** |
| Ciprofloxacin 500mg PO BID or Septra DS PO BID x 10-14 days<br>Consider US/CT imaging for complicated UTI |
| **Complicated Pyelonephritis** |
| Ceftriaxone 1g IV q24h |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 99. NEJM 2014; 371(12):1100-10. Cochrane DB Syst Rev 2014;4:CD008509

# Environmental Injuries

## Hypothermia (T <35°C)

**Causes:** ↑ heat loss (EtOH, environmental), ↓ thermogenesis (hypothyroidism, hypoglycemia, adrenal insufficiencies), impaired thermogenesis (toxins, CNS lesions, SC injury)
**Risk Factors:** low SES, age extremes, drug OD, psych comorbidities

### Assessment

Mild (32° – 35°C): excitation response (↑ HR/BP/RR, shivering)
Moderate (28° – 32°C): physiologic slowing, NO shivering, AMS, ataxia
Severe (24° – 28°C): dysrhythmias (brady>slow Afib>Vfib>asystole), irritable myocardium (avoid invasive heart procedures), fixed/dilated pupils

### Investigations

Labs: CBC, lytes, BUN, Cr, VBG, lactate, INR/PTT, glucose
Tests: ECG (Osborne waves), pCXR (aspiration, pulmonary edema)

### Management

| General |
|---|
| Monitors, $O_2$, IV access, vitals, esophageal or Foley temp<br>Remove wet clothes, rewarming strategies |
| **Cardiac Arrest** |
| Modified ACLS protocol (pulse checks 60 mins, shock x3 cycles then wait >30°C, withhold Epi until >30°C then double interval until >35°C |
| **Passive Rewarming (T >32°C)** |
| Cover patients with insulating blanket, let body generate heat |
| **Active Rewarming (T <32°C)** |
| **Active External:** warming blankets, radiant heat, heating pads<br>**Active Internal:** warm IV fluids, warmed O2, dialysis, ECMO, heated cavity lavage (pleural, gastric, peritoneal, bladder) |

## Heat Stroke (T >40.5°C)

***Differentiated from heat exhaustion by AMS/elevated LFTs**

Classic/Non-Exertional: elderly, heat waves, indoors with no AC
Exertional: young athletes, runners

### Assessment

Classic: dry/hot skin, not always dehydrated, HIGHER mortality
Exertional: diaphoretic, profound dehydration, more morbidities (liver failure, renal failure, DIC, lactic acidosis)

### Management

| General | |
|---|---|
| Monitors, cooled IV fluids, rapid evaporative cooling<br>Antipyretics NOT effective (as not a hypothalamus problem, can also make DIC/liver failure worse) | |
| **Treat Symptoms** | |
| **Shivering:** Midazolam 2mg IV<br>**Seizures:** Lorazepam 2mg IV | **Rhabdomyolysis:** IVF, Lasix, NaHCO3<br>**Hyperkalemia:** protect, shift, eliminate |

**EMOttawa Blog Posts:** Hypothermia Part 1, Part 2

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 138+139. Resuscitation 2015;95:148-201.

# Orthopedic Injuries – Upper Limb

## Assessment

History: mechanism of injury, associated neurological symptoms, blood loss
Exam: ABCs +vitals, look + feel, active and passive ROM, neurovascular status, assess bleeding/open fractures, skin tenting, complications of compartment syndrome, examine joint above and below fracture
Investigations: radiographs as clinically indicated

## Upper Limb

**Distal Radius Fracture**: FOOSH. Several fracture patterns. Colle's fracture is most common (distal radial fracture with dorsal displacement, volar apex angulation, and is extra-articular).
Exam: "dinner fork deformity" if dorsally angulated as in Colle's fracture.
Management: hematoma block, reduction to restore radial length and correct dorsal angulation. Success of reduction depends on several factors (intra- vs. extra-articular, comminution, quality of cast mold).

Colle's Fracture

**Scaphoid Fracture**: 15-40yo with FOOSH. High complication rate (5-40% with AVN/non-union).
Exam: limited wrist/thumb ROM, snuff box tenderness, axial loading of 1st MC, pain to scaphoid tubercle volarly.
Management: thumb spica splint for suspected fractures (even if negative X-ray) x 6-12 weeks, repeat imaging in 10 days.

Scaphoid Fracture

**Proximal Humeral Fracture**: high energy trauma (young), FOOSH (elderly). Neer classification to determine 1/2/3/4 part fracture. Separate part if displaced > 1cm or >45° angulation.
Management: minimally displaced (sling or cuff-and-collar immobilization), displaced GT or 2/3/4 part in younger patients (ORIF)

Proximal Humeral Fracture

**Boxer's Fracture**: blow on distal-dorsal aspect of closed fist. Volar angulation of neck of 5th metacarpal into palm.
Management: closed reduction if angulation >40°. If stable, ulnar gutter splint for 4-6 weeks.

Boxer's Fracture

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 44, 45, 51, 58.

# Orthopedic Injuries – Lower Limb

## Assessment

History: mechanism of injury, associated neurological symptoms, blood loss
Exam: ABCs +vitals, look + feel, active and passive ROM, neurovascular status, assess bleeding/open fractures, skin tenting, complications of compartment syndrome, examine joint above and below fracture
Investigations: radiographs as clinically indicated, use decision rules for ankle/foot/knee to guide assessment

## Lower Limb

**Ankle Fracture:** inversion/eversion injury. Risk-stratification based on Weber's classification.
**Weber A:** below syndesmosis – typically stable
**Weber B:** at level of syndesmosis – can be unstable
**Weber C:** above level of syndesmosis – always unstable
Management: non-operative (non-WB BK cast), operative (most of Weber Type B/all Type C)

Weber A Fracture

**Jones Fracture:** Stress injury. Midshaft 5th MT fracture (>15mm from proximal end of 5th MT). High incidence of non-union.
Management: non-WB BK cast x6 weeks.

Jones Fracture

**Pseudo-Jones Fracture:** Traumatic injury. Proximal tubercle of 5th MT (<15mm from proximal end of 5th MT). Non-union is uncommon.
Management: protective weight bearing in stiff soled shoe or boot.

**Hip Fracture:** fall (elderly), direct force to hip, rotational force.
**Garden I:** incomplete, valgus impacted
**Garden II:** complete, non-displaced
**Garden III:** complete, partially displaced
**Garden IV:** complete, fully displaced
Exam:
shortened/abducted/externally rotated leg, painful ROM
Management: Elderly may get hemi or total hip arthroplasty. Young adults get ORIF.

Garden Classification

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 51+58. Clin Orthop Relat Res. 2018 Feb; 476(2): 441–445.

# Pediatric Orthopedic Emergencies

## General:

**History:** mechanism of injury, associated neuro symptoms, blood loss, consider non-accidental trauma

**Exam:** Vitals, look + feel, active & passive ROM, neurovascular status, assess bleeding/open #s, skin tenting, signs of compartment syndrome (tight compartments, pain w passive stretch), examine joint above & below fracture

**Investigations:** X-ray, rarely MRI

## Physeal Fractures:

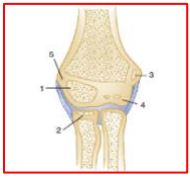
Use Salter-Harris classification with **SALTER** mnemonic

| | |
|---|---|
| **Type I** | **S**traight through physis |
| **Type 2** | **A**bove physis |
| **Type 3** | **L**ower than physis |
| **Type 4** | **T**hrough **E**verything (above & below) |
| **Type 5** | **R**ammed (erasure of physis) |

## Supracondylar Fractures:

Most common elbow fracture in peds. Can mimic ossification centres. Remember with **CRITOE** mnemonic (average age of appearance)

| | |
|---|---|
| **C**apitellum | 1 year |
| **R**adial head | 3 years |
| **I**nternal (medial) epicondyle | 5 years |
| **T**rochlea | 7 years |
| **O**lecranon | 9 years |
| External (lateral) epicondyle | 11 years |




**Ossification Centres**

## Atraumatic Pediatric Hip Pain:

| | |
|---|---|
| **Septic Arthritis** | Bacterial joint infection of the hip, M > F, S. Aureus (most common) |
| **Transient Synovitis** | Most common cause of atraumatic hip pain, self-resolving inflammatory process, often post-viral or minor trauma, peak 3-6 yrs, M > F |
| **Legg-Calve-Perthes Disease (LCPD)** | Idiopathic necrosis of capital femoral epiphysis, M > F, peak 3-11 yrs, mostly unilateral but can be bilateral |
| **Slipped Capital Femoral Epiphysis (SCFE)** | Slippage of the proximal femoral epiphysis, M > F, peak 8-15 yrs, frequently bilateral, most common hip disorder in adolescents<br>RFs: obesity, M > F, endocrinopathies |

## Assessment

| | |
|---|---|
| **Septic Arthritis** | Typically febrile, unable to weight bear, erythema, limited passive ROM, swelling/warmth/erythema, irritability/lethargy/malaise, hip in flexion, external rotation, and abduction |
| **Transient Synovitis** | Typically afebrile, able to weight bear with pain, hip in flexion, external rotation, and abduction |

| | |
|---|---|
| **LCPD** | Limp, Trendelenburg sign, limited internal rotation and abduction of hip, pain can be referred to knee or groin, worse with activity, lower limb length disparity in severe cases |
| **SCFE** | Poorly localized pain, often referred, antalgic gait, limited hip internal rotation, Drehmann sign (external rotation with hip flexion) |

## Investigations

| | |
|---|---|
| **Septic Arthritis** | CBC, ESR, CRP, blood cx, X-rays, US, synovial fluid cell count, differential, gram stain, and cultures<br>Kocher criteria (see below) |
| **Transient Synovitis** | Same as septic arthritis (must exclude septic arthritis) |
| **LCPD** | Hip x-rays (AP pelvis, frog leg lateral) |
| **SCFE** | Hip x-rays (AP pelvis, frog leg lateral +/- cross-table lateral) |

**Kocher Criteria (Walk FEW):**

| Elements (+1pt each) | Interpretation (%Risk) |
|---|---|
| Inability to **W**alk/**W**eight bear<br>**F**ever >38.5ºC<br>**E**SR >40<br>**W**BC >12 | 0 pts (0.2%)<br>1 pt (3%)<br>2 pts (40%)<br>3 pts (93%)<br>4 pts (99%) |

## Management

| | |
|---|---|
| **Septic Arthritis** | IV antibiotics<br>Consult Ortho |
| **Transient Synovitis** | Symptom management (NSAIDs, joint rest)<br>Dispo home<br>Re-assessment if symptoms persist or worsen |
| **LCPD** | Consult Ortho |
| **SCFE** | Non-weight bearing<br>Consult Ortho |

## Common Forearm Injuries:

**Nightstick Fracture:** Isolated ulnar shaft fracture by direct blow to forearm.

**Buckle Fracture:** Linear compression resulting in buckling of bone without cortical disruption. Common at metaphyseal-diaphyseal junctions.

**Greenstick Fracture:** Fracture disrupting the cortex unilaterally.

**Nursemaid's Elbow:** Radial head subluxation. Radial head displaced from annular ligament typically due to axial traction on forearm. Clinical dx treated with supination/flexion or hyperpronation maneuvers.

Nightstick

Greenstick

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 10th ed, 2023; Chapter 170. Ortho Bullets.

# Pediatric Fever

## Definitions

Fever: Temp >38.0ºC, rectal most accurate
Fever without a source: <3 yo, no identifiable source of fever after initial history/exam
Fever of unknown origin: fever lasting 2+ weeks, without known cause after initial investigations
Serious Bacterial Infection (SBI): includes UTI, meningitis, bacteremia
Invasive Bacterial Infection (IBI): includes meningitis, bacteremia

## Differential Diagnosis

Respiratory tract infections (viral = most common or pneumonia), UTI, otitis media, skin infections, GI (i.e. gastroenteritis), surgical (i.e. appendicitis), environmental (i.e. hyperthermia), rheumatologic (i.e. JIA), oncologic (i.e. ALL), Kawasaki disease (≥5d fever)

## Assessment

Pregnancy and Birth Hx: Gestational hx (i.e. U/S, maternal immunization status, screening), birth hx (fever, prolonged labour, GBS status), NICU stay
PMHx: Immunization status, previous infections or surgeries
Fever Hx: duration (clarify if daily fever or breaks between fevers), route of measurement

| Important Notes |
| --- |
| 1. Treat tactile fever equally as a documented fever in neonates<br>2. Rectal = most reliable |

History: Localizing symptoms (cough/congestion/sore throat, ear pain, headache/neck stiffness, N/V/D, dysuria/frequency/urgency/hematuria, rash), lethargy (i.e. somnolence), irritability (i.e. inconsolable), decreased po intake, urine output, aLOC, seizures, sick contacts, travel history, exposure to genital/oral herpes

Physical Exam: Vitals, pediatric triangle (see below)
**CV/Resp:** tachycardia, crackles, wheezing
**Abdo:** organomegaly, masses, guarding
**Eyes:** conjunctivitis, discharge
**ENT:** tympanic membrane, external ear canal, oropharynx (Koplik spots in measles, pharyngitis, strawberry tongue, herpetic lesions, mucositis)
**GU:** candida, diaper dermatitis
**Neuro:** nuchal rigidity, bulging fontanelle, lethargy, focal neuro signs
**Skin:** petechiae, viral exanthems

### Pediatric Triangle (ABC):

| | |
| --- | --- |
| **Appearance** | **TICLS: T**one, **I**nteractiveness, **C**onsolability, **L**ook and gaze, **S**peech and cry |
| **Breathing** | Tripod position, tachypnea, hot potato voice, stridor, wheezing, retractions (suprasternal, supraclavicular, intercostal, subcostal), grunting, nasal flaring, head bobbing, seesaw breathing |
| **Circulation** | Delayed cap refill, extremity mottling, cyanosis |

### Important Bacterial Pathogens

| | |
| --- | --- |
| **0-28d** | GBS, E. coli, Listeria |
| **29-60d** | H. influenza, S. pneumo, N. meningitides, E. coli |
| **>60 d** | S. pneumo, N. meningitides, E. coli |

## Investigations

IMs = inflammatory markers (procalcitonin > 0.5ng/mL, CRP >20 mg/L, ANC > $5.2x10^9$/L, T>38.5ºC if procalcitonin not available)

| 0-60 days | |
|---|---|
| **Everyone** | Urinalysis (U/A), urine cx if +U/A, blood cx, IMs* |
| **0-21d** | LP, urine cx always with U/A |
| **22-28d** | **-ve IMs**: shared-decision making regarding LP<br>**+ve IMs:** LP |
| **29-60d** | **-ve IMs:** no LP<br>**+ve IMs:** shared decision-making regarding LP |
| **60+ days** | |
| U/A (cx if +ve), others (i.e. CBC, CXR) rarely needed unless fever ≥5 d | |

**Urine:** bag sample or midstream to screen, catheterization or midstream urine for culture if starting Abx

**Considerations for CXR:** persistent tachypnea despite fever treatment, abnormal SpO2 i.e. <95%, increased work of breathing, focal findings on auscultation, persistent fever x5 days, chest pain

**CSF studies:** Tube 1 (culture + sensitivity), Tube 2 (protein + glucose), Tube 3 (cell count + diff), Tube 4 (+/- HSV PCR, hold for other studies)

## Management

### Initial Doses:

Ampicillin = 50mg/kg IV q6h (200mg/kg/day)
Tobramycin = 7mg/kg IV q24hr (7mg/kg/day); monitor trough levels
Acyclovir = 15-20mg/kg IV q8h (45-60mg/kg/day)
Cefotaxime = 50 mg/kg IV q6h (200mg/kg/day)

| Age | Antimicrobials | | Disposition |
|---|---|---|---|
| **0-21d** | Amp & Tobra, +/- Acyclovir (if HSV risk factors/unwell) | | Admit |
| **22-28d** | **Positive IMs** | **+ve UA** or **+ve IMs with -ve CSF**: Amp & Tobra<br>**+ve CSF:** Cefotaxime +/- Amp | Admit |
| | **Negative IMs** | Consider Ceftriaxone<br>**-ve CSF:** shared decision making (admit vs discharge) | Admit if no LP |
| **29-60d** | **Positive IMs** | **-ve CSF**: Amp & Tobra<br>**+ve CSF:** Cefotaxime +/- Amp | Admit |
| | **Negative IMs** | D/C home<br>Abx if **+ve UA**: PO Keflex or Cefixime +/- IV dose x1 | Discharge |
| **>60d** | Treatment based on specific cause | | |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 10th ed, 2023; Chapter 161. AAP Clinical Practice Guideline for Management of Well-Appearing Febrile Infants (8-60d) adapted by Dr. Michelle Long, CHEO.

# General Surgery Emergencies

## Biliary Pathologies:

Cholelithiasis: Presence of gallstones (cholesterol pigmented or mixed)
Risk Factors (5F's): **F**orties, **F**emale, **F**ertile, **F**atty tissue (obese), **F**Hx

| | |
|---|---|
| **Biliary Colic** | Transient cystic duct obstruction |
| **Cholecystitis** | Gallbladder (GB) inflammation due to persistent cystic duct obstruction |
| **Choledocholithiasis** | Common bile duct (CBD) gallstone obstruction |
| **Gallstone Pancreatitis** | Gallstone blocking pancreatic duct leading to obstruction and inflammation |
| **Cholangitis** | Infection of the biliary tract due to choledocholithiasis |

### Assessment

| | |
|---|---|
| **Biliary Colic** | RUQ pain, N/V<br>Post-prandial (fatty meals), w/in hrs of last meal<br>Intermittent, should dissipate<br>Radiation to right shoulder/scapula<br>Entire episode lasts approx 1-6 hrs |
| **Cholecystitis** | RUQ pain, N/V<br>Fever<br>+'ve Murphy's sign<br>Often previous hx of biliary colic |
| **Choledocho-lithiasis** | RUQ pain, N/V<br>Jaundice<br>Can lead to cholangitis or gallstone pancreatitis |
| **Ascending Cholangitis** | N/V, hypotension<br>**Charcot's Triad:** Fever, jaundice, RUQ pain<br>**Reynold's Pentad:** Charcot's triad, hypotension, aLOC |

### Investigations

Labs: CBC, BUN, Cr, lytes, LFTs, total & direct bilirubin (direct >½ total with GB obstruction), lipase (or amylase depending on centre) +/- VBG, blood cx
Imaging: RUQ US or CT (if broader Ddx); if dx remains unclear → MRCP or ERCP +/- EUS, oral cholecystography, hepatobiliary iminodiacetic acid (HIDA scan)

| Pathology | WBC | ALP | GGT | ALT | AST | Bili |
|---|---|---|---|---|---|---|
| **Biliary Colic** | N | N | N | N | N | N |
| **Cholecystitis** | ↑ | N /↑ | N /↑ | N /↑ | N /↑ | N |
| **Choledocholithiasis** | N | ↑ | ↑ | N/↑ | N/↑ | ↑ |
| **Ascending Cholangitis** | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ |

### Management

| |
|---|
| **Biliary Colic** |
| Correct fluid and electrolyte imbalances, symptom management<br>Outpatient Gen Sx referral: Cholecystectomy considered for >/= 2 episodes or crescendo biliary colic (i.e. symptoms impacting daily function/unable to eat)<br>Dispo: Home |
| **Cholecystitis** |
| Correct fluid and electrolyte imbalances, symptom management, NPO<br>Abx: Ceftriaxone (CTX)<br>Dispo: Inpatient Gen Sx for cholecystectomy (chole) |
| **Choledocholithiasis** |
| Correct fluid and electrolyte imbalances, symptom management, NPO<br>Dispo: Inpatient GI for ERCP, Gen Sx for eventual chole |
| **Cholangitis** |

Correct fluid and electrolyte imbalances, symptom management, NPO
Hemodynamic stabilization
**Abx:** CTX & Flagyl; Pip-Tazo if severe
**Dispo:** Often sick and require ICU or stepdown, GI for ERCP, Gen Sx for percutaneous drain (temporizing in critically ill) and eventual chole

## Acute Appendicitis:

Pathophysiology: Obstruction, inflammation, and infection of appendix
Background: Most common surgical cause of acute abdo pain in pts <50

### Assessment

| | |
|---|---|
| **History** | Progressively worsening periumbilical pain<br>Migrates to RLQ within 12h<br>N/V, fever, anorexia |
| **Physical Exam** | McBurney's point tenderness, Psoas & Obturator signs,<br>Rovsing's sign, rebound tenderness, Jump test (peds)<br>Focal peritonitis (guarding, rigidity) suggests perforation |
| **Pitfalls** | <50% pts have classic migratory pain<br>Acute appendicitis can be very difficult to exclude/diagnose |

### Investigations

Labs: CBC, Cr, lytes, LFTs, bili, lipase (amylase), CRP/ESR (peds), U/A, blood cx
Imaging: Abdo US, CT (larger body habitus or –'ve US), MRI (pregnancy)
Scores: Alvarado score, Pediatric appendicitis score, Appendicitis inflammatory response score

### Management

Supportive: NPO, IV fluids, analgesia, anti-emetics
Abx: CTX & Flagyl
Dispo: Admit, Gen Sx for appendectomy

## Diverticular Disease:

| | |
|---|---|
| **Diverticulosis** | Colonic diverticula |
| **Uncomplicated** | Diverticulosis + peri-colonic fat inflammation +/- micro abscess/perforation |
| **Complicated** | Diverticulitis + significant abscess/perforation |

### Assessment

History: LLQ pain (80% patients in North America), change in bowel habits, N/V/D or constipation, fever, anorexia, dysuria (colovesical fistula), vaginal discharge (colovaginal fistula)
Physical Exam: Fever, LLQ tenderness, focal peritonitis (guarding, rigidity) suggests perforation, palpable mass (complicated/abscess)

### Investigations

Labs: CBC, BUN, Cr, lytes, CRP/ESR (may indicate more complicated disease)
Imaging: CT abdo w contrast (esp. in 1st time presenters), US if limited access

### Management

Supportive: analgesia, antiemetics, antipyretics
Diet: Clear liquid/soft diet initially, advance to diet as tolerated
Antibiotics: Routine Abx may not be necessary in select patients for uncomplicated diverticulitis. Follow local institution practices.
Uncomplicated: Clavulin 875/125mg PO BID or Cipro 500mg PO BID + Flagyl 500mg PO TID x 5-10 days
Complicated: Admit to Gen Sx, NPO, CTX 1g IV q24h + Flagyl 500mg IV q8h

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 10th ed, 2023; Chapter 76, 79 & 81.

# Toxicological Emergencies

## Differential Diagnosis

| "Hot and Crazy" (DIMES) |
|---|
| **D**rug-related: sympathomimetics (cocaine, amphetamines, caffeine, PCP, ketamine), anticholinergics, ASA, SS/NMS/MH, EtOH withdrawal<br>**I**nfection: meningitis, encephalitis, sepsis<br>**M**etabolic: hypoglycemia, uremia, electrolytes, thyrotoxicosis, pheo<br>**E**nvironmental: heat stroke<br>**S**tructural: ICH |
| **"Low and Slow" (ABCDO)** |
| **A**DHD tablets (clonidine)<br>**B**-blockers<br>**C**alcium-channel blockers<br>**D**igoxin<br>**O**piates/**O**rganophosphates |

## Common Toxidromes

| | |
|---|---|
| **Anticholinergics** | |
| **Vitals:** hyperthermia, tachycardia<br>**Signs:** mydriasis, dry skin<br>**Symptoms:** agitation, hallucination, constipation, urinary retention<br>"dry as a bone, red as a beet, blind as a bat, mad as a hatter, hot as a hare" | Antidepressants<br>Antihistamines<br>Antipsychotics<br>Antispasmodics<br>Atropine<br>Carbamazepine |
| **Cholinergics** | |
| **Vitals:** hypotension, bradycardia<br>**Signs:** miosis, diaphoresis, seizures<br>**Symptoms:** urination, bronchospasm, vomiting, diarrhea | Organophosphates<br>Nerve gas<br>Mushroom<br>Anticholinesterase |
| **Sympathomimetics** | |
| **Vitals:** hyperthermia, tachycardia, HTN<br>**Signs:** mydriasis, diaphoresis, seizures<br>**Symptoms:** agitation, anxiety | Amphetamines<br>Cocaine<br>LSD<br>Ephedrine |
| **Sedative/Hypnotics** | |
| **Vitals:** hypothermia, hypotension, bradypnea<br>**Signs:** respiratory depression, miosis (opioids), altered LOC | EtOH, BZDs, GHB<br>Opioids (morphine, heroin, fentanyl)<br>Barbiturates |

## Basic Approach (ABCDE)

| | |
|---|---|
| **Airway** | Intubate early if impending airway compromise |
| **Breathing** | Think metabolic derangements if low RR |
| **Circulation** | Ensure patient is well perfused |
| **Detect and Correct** | Consider universal antidotes (**D**extrose, **O**xygen, **N**aloxone, **T**hiamine), correct vitals, correct signs (i.e. seizure), consider decontamination/enhanced elimination |
| **Emergency Antidotes** | Specific antidotes and treatments |

# Vascular Emergencies

## Ruptured AAA

**Risk Factors:** FHx, HTN, PVD/CAD, DM, connective tissue disease, smoking

| AAA <5cm | AAA 5cm - 7cm | AAA >7cm |
|---|---|---|
| 0.3% risk of rupture/yr | 10% risk of rupture/yr | 20% risk of rupture/yr |

### Assessment

Classic Triad: acute onset back/abdo/flank pain + hypotension (with or without syncope) + pulsatile abdominal mass

Other Presentations: syncope, UGIB/LGIB, high output CHF, ureteral colic, bowel obstruction symptoms, neurological symptoms

**Tests:** PoCUS to detect AAA (>3cm), ECG, CT aortogram (if stable)

### Management

**General**

ABCs, monitors, oxygen, vitals, IV access
STAT vascular surgery consult

**Resuscitation**

IV crystalloids, blood (aim for systolic BP 90 – 100mmHg)
Massive transfusion protocol

**Urgent Surgical Intervention**

Open surgery with graft replacement or endovascular aneurysm repair

**Post-op Complications**

**Infection:** graft contamination or hematogenous seeding
**Ischemia:** Spinal cord ischemia, CVA, visceral ischemia, erectile dysfunction
**Aortoenteric fistula:** commonly presents as GI bleeding
**Endo Leak:** blood flow outside of the graft lumen

## Acute Arterial Occlusion

**Definition:** acute embolus or arterial thrombosis, true emergency as irreversible damage can occur within 6-8 hours

Risk Factors: atherosclerosis, MI with LV thrombus, Afib, valve stenosis, stent/grafts

### Assessment

History (6Ps): **P**ain, **P**aresthesia, **P**allor, **P**olar (cold), **P**ulselessness, **P**aralysis (late finding)

**Investigations:** Doppler probe to leg with proximal BP cuff – perfusion pressure <50mmHg, ABI <0.5

### Management

**STAT vascular surgery consult**

Immediate heparinization with 4000 IU bolus
Revascularization (i.e. embolectomy) vs. CT angiogram (depends on if emboli from Afib vs. secondary to PVD)

# Psychiatric Emergencies

**Background:** ask every patient **MOAPS: M**ood (depression, mania), **O**rganic (EtOH, drug use), **A**nxiety (worries, obsessions, phobias), **P**sychosis (hallucinations or delusions) and **S**uicidal/homicidal thoughts

**Suicide Risk Factors:** **SAD PERSONS: S**ex (male); **A**ge (<19 or >45); **D**epression or hopelessness; **P**revious attempts or psychiatric care; **E**tOH/substance use (excessive); **R**ational thinking loss; **S**ocial supports lacking; **O**rganized suicidal plan or serious attempt; **N**o spouse; **S**ickness

## Assessment

| Depression | Schizophrenia |
|---|---|
| ≥5 sx (≥1 must be ↓ mood or interest) for 2+ wks. **MSIGECAPS:**<br>**M**ood low<br>**S**leep increased or decreased<br>**I**nterest decreased<br>**G**uilt or worthlessness<br>**E**nergy decreased<br>**C**oncentration decreased<br>**A**ppetite increased or decreased<br>**P**sychomotor retardation / agitation<br>**S**uicidal ideation | ≥2 sx (of which ≥1 must be a, b or c) each present for >1 month; 6 months altered behaviour required to make dx<br>a) **Hallucinations**<br>b) **Delusions** (bizarre or non-bizarre)<br>c) **Disorganized speech** (i.e. frequent derailment or incoherence)<br>d) **Grossly disorganized**/catatonic **behaviour**<br>e) **Negative symptoms** (i.e. flat affect, avolition, alogia) |
| **Generalized Anxiety** | **Mania** |
| ≥3 of 6 sx majority of days for 6+ months. **BE SKIM:**<br>**B**lank mind/difficulty concentrating<br>**E**asily fatigued<br>**S**leep disturbance<br>**K**eyed up/on-edge/restless<br>**I**rritability<br>**M**uscle tension | ≥3 sx with euphoria; ≥4 sx with irritable mood for 1+ wk. **GST PAID:**<br>**G**randiosity<br>**S**leep (decreased need for)<br>**T**alkative/pressured speech<br>**P**leasurable activities with painful consequences<br>**A**ctivity ↑(goal-directed)/agitation<br>**I**deas (flight of)<br>**D**istractable |

## Investigations

Labs: CBC, lytes, B12, Vit D, TSH, BUN, Cr, LFTs, serum EtOH & Tylenol level, urine tox

**Safety Assessment**

1. Do you have any **thoughts** that life isn't worth living?
2. Do you have a **plan** to take your life?
3. **Imminence/Means:** When do you plan to complete this plan? Do you have the means available to complete this plan?
4. **Protective Factors** What prevents you from carrying out this plan?
5. **Future Orientation:** What are your plans after you leave hospital?
6. **Hopefulness**: Do you think you can get better? Are you improving?
7. **Assess Previous Attempts:** organization/lethality, no remorse after, attempt isolated location, affairs in order (will, belongings given away)

## Management

| | |
|---|---|
| **Depression** | 1st line: SSRIs, SNRIs, NDRIs, CBT, Behavioural Activation |
| **Anxiety** | 1st line: SSRIs, SNRIs, CBT, Pregabalin (GAD), |
| **Schizophrenia** | 1st line: atypical antipsychotics (Paliperidone, Aripiprazole, Olanzapine, Risperidone, Quetiapine) |
| **Mania** | 1st line: mood stabilizers (Lithium, Valproic Acid), atypical antipsychotics (Quetiapine, Aripiprazole) |

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice - 9th ed, 2017; Chapter 100.

# Thyroid Emergencies

## Types of Thyroid Emergencies

| HYPERthyroidism | HYPOthyroidism |
|---|---|
| Graves' disease<br>Toxic multinodular goiter<br>Toxic adenoma<br>Thyroiditis (autoimmune, postpartum, amiodarone, infectious, traumatic) | Hashimoto's thyroiditis<br>Drug-induced (lithium, amiodarone)<br>Insufficient dietary iodine<br>Central hypothyroidism (hypothalamic or pituitary dysfunction, brain injury, mass) |

**Thyroid Storm:** Severe thyrotoxicosis. Pyrexia (40-41ºC), tachycardia, altered mental status, cardiovascular collapse, hypotension, abdominal pain, and signs of hyperthyroidism (lid lag, goiter, ophthalmopathy, tremor)l **Burch and Wartofsky Score** can help distinguish between true Thyroid Storm vs Thyrotoxicosis
**Myxedema Coma:** Life-threatening event precipitated by stress in untreated hypothyroidism. Hypothermia (<36 ºC), altered mental status, hypotension, hypoventilation, bradycardia, acute precipitating illness, and signs of hypothyroidism (dry skin/hair, reduced reflexes, bradykinesia, facial edema).

## Assessment

History: constitutional symptoms, thyroid disease, recent acute illness, altered mental status, skin and hair changes, palpitations or bradycardia, abdominal pain, dyspnea, cold or heat intolerance, medications, recent surgery
Physical Exam: vitals, cardiac exam, ophthalmologic exam, neck exam for thyroid enlargement, dysphagia, dysphonia

## Investigations:

Labs: can help identify underlying trigger: CBC, TSH, free T3 & T4, ECG, glucose, VBG, troponin, b-hCG (pregnancy can trigger thyrotoxicosis), septic workup (common trigger for myxedema coma)
Tests: ECG; POCUS: assess cardiac fn, rule out pericardial effusion; consider CT head if signs of trauma or focal neuro deficits

| TSH | Free $T_4$ | Free $T_3$ | Disease |
|---|---|---|---|
| Low | High | High | Hyperthyroidism |
| Low | Normal | Normal | Subclinical hyperthyroidism |
| Low | High | Normal | Thyroiditis |
| Low | Low | Low | Central hypothyroidism |
| High | Low | Low | Hypothyroidism |
| High | Normal | Normal | Subclinical hypothyroidism |

## Management

**Thyroid Storm**

**$\beta$-adrenergic blockade:** Propranolol 60-80mg PO or 1mg IV, Esmolol infusion (if CHF)
**Inhibit thyroid synthesis:** PTU 1g PO or Methimazole 30mg PO
**Block thyroid release:** SSKI 1-2 drops PO TID, Lugol's 5-7 drops PO TID (1hr after PTU/Methimazole)
**Inhibit $T_4$ to $T_3$ conversion:** Hydrocortisone 300 mg IV
**Supportive:** volume resuscitation, cooling measures, anxiolytics, consider bile acid sequestrants, treat underlying precipitant
**Consult:** ICU and Endo

**Myxedema Coma**

**Resuscitation**: fluid resuscitation, broad spectrum antibiotics, airway support
**Thyroid Hormone Replacement:** $T_4$ 400 mcg IV and $T_3$ 20 mcg IV
**Steroids:** Hydrocortisone 100 mg IV
**Supportive**: passive rewarming

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 120.

# Pain Management

**Reflex Responses to Pain:** ↑ HR, RR and BP, ↑ metabolic rate and $O_2$ consumption, ↓ urinary and gastric tract tone (urinary and bowel retention)
**General Approach:** patient-centred, target specific pain syndromes, and use non-pharmacological and pharmacological approaches

## Non-Opioid Analgesics

| **Acetaminophen** | |
|---|---|
| First line foundational analgesia<br>Combine with NSAIDs to improve efficacy | Tylenol<br>975mg PO |
| **NSAIDs** | |
| **Ibuprofen and Naproxen:** best safety profile and least side effects<br>**Ketorolac:** helpful in acute painful condition<br>**Topical NSAID preparations:** added analgesia for acute MSK and joint pain<br>If prescribing NSAIDs, consider concomitant PPI therapy in patients with higher risk of GI bleeds | Ibuprofen<br>400 – 800mg PO<br>Naproxen<br>500mg PO<br>Ketorolac<br>10 – 30mg IM/IV |
| **Ketamine** | |
| Sub-dissociative doses are effective for analgesia<br>Administer over 20 minutes to minimize risk of emergence reaction | Ketamine<br>0.1 – 0.3mg/kg IV<br>Over 20 mins |
| **Regional and Local Nerve Blocks** | |
| Useful in lacerations, acute fractures requiring reduction or operation, and headaches (i.e. occipital neuralgia) | Lidocaine + Epi<br>Max 7mg/kg<br>Lidocaine – Epi<br>Max 5mg/kg<br>Bupivacaine<br>Max 2.5-3mg/kg |

## Opioid Analgesics

| **Morphine** | |
|---|---|
| Pros: less abuse potential, palliative care pain, cancer pain, dosing range well known<br>Cons: active metabolites may accumulate in renal insufficiency | PO: 0.5mg/kg<br>IV/SC: 0.1mg/kg |
| **Hydromorphone** | |
| Pros: easier titration, more equipotent, better tolerated in renal insufficiency<br>Cons: initial dosing range unclear, more side effects | PO: 1-2mg<br>IV/SC: 0.5-1mg |
| **Fentanyl** | |
| Pros: most effective for acute pain (fractures, trauma)<br>Cons: abuse potential, overdose potential, long ½ life | IV/SC: 25-50µg |

## Gabapentinoids

| **Pregabalin & Gabapentin** | |
|---|---|
| Ideal for neuropathic pain | Pregabalin: 50mg PO TID upto 300mg/day<br>Gabapentin: 300mg PO TID upto 2400mg/day |

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 3. 2017 Canadian Guideline for Opioids for Chronic Non-Cancer Pain. Source: http://nationalpaincentre.mcmaster.ca/guidelines.html

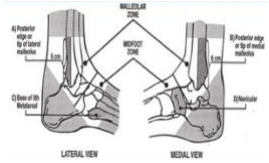
# Clinical Decision Rules

## Canadian CT Head Rule for Minor Head Injury

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Head injury resulting in witnessed LOC/disorientation or definite amnesia; initial ED GCS >13; injury within 24hrs | Minimal head injury, obvious penetrating skull injury, acute neurological deficits, unstable vital signs assoc. with major trauma, seizure prior to ED assessment, bleeding disorder, pregnant |
| **High Risk Criteria (neurological intervention)** | |
| GCS <15 at 2 hrs after injury, suspected open or depressed skull fracture, signs of basal skull fracture, vomiting >2 episodes, age >65 | |
| **Medium Risk Criteria (for brain injury on CT)** | |
| Amnesia before impact >30 mins, dangerous mechanism | |

## Ottawa Ankle Rules

| Inclusion Criteria |
|---|
| Adult patient (ALSO been validated in pediatrics), any mechanism of blunt ankle injury |
| **Exclusion Criteria** |
| Age <18, pregnant, isolated skin injury, injury >10 days, reassessment of same injury |




| Ankle X-ray only required if |
|---|
| Bony tenderness at A OR B OR inability to take 4 complete steps in ED |
| **Foot XR only required if** |
| Bony tenderness at C OR D OR inability to take 4 complete steps in ED |

## Ottawa Knee Rules

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Adult patient, blunt knee injury, "knee" = patella, head/neck of fibula, proximal 8cm of tibia and distal 8cm of femur | Age <18, pregnant, isolated skin injury, injury older than 7 days, return for reassessment, AMS, paraplegic, multi-trauma |
| **Knee X-ray only required if** | |
| Age >55 OR isolated patellar tenderness OR fibular head tenderness OR inability to flex 90º OR inability to take 4 complete steps in ED | |

## Ottawa SAH Rule

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Alert patients >15, new severe atraumatic headache, max intensity within 1 hr | New neurological deficits, prior aneurysm, prior SAH, known brain tumors, chronic recurrent headaches (>3 headaches of same character/intensity for >6 months) |
| **CT is indicated if any criteria are present** | |
| Neck pain/stiffness, witnessed LOC, age >40, onset during exertion, thunderclap headache, limited neck flexion on examination | |

Key References: BMJ 2010; 341:c5204. Ann Emerg Med 1992; 21(4):384-390. Ann Emerg Med 1995; 26(4):405-413. Lancet 2001; 357(9266):1391-6.

# Risk Stratification Scales

## Canadian Syncope Risk Score

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Age >16, present to ED with syncope within 24 hours | Prolonged (>5 min) LOC, AMS, witnessed seizure, major trauma, intoxication, language barrier, head trauma |

| Clinical Evaluation | Investigations | ED Diagnosis |
|---|---|---|
| **-1** Vasovagal predisposition<br>**+1** Hx heart disease<br>**+2** sBP<90 or sBP>180 | **+2** Elevated TnI<br>**+1** QRS axis <-30° or >100°<br>**+1** QRS >130ms<br>**+2** Corrected QT>480ms | **-2** Vasovagal syncope<br>**+2** Cardiac syncope |

| Interpretation | **Total score = -3 to 11**<br>**Score of 0** = 1.9% risk of serious adverse event within 30d<br>**Score of 11** = 83.6% risk of serious adverse event within 30d |
|---|---|

## Ottawa Heart Failure Risk Scale

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Age >50, symptoms consistent with CHFe (acute SOB, fluid retention, underlying cardiac abnormality) and/or response to diuretics | $O_2$ <85%, HR>120, sBP<90, confusion, ischemic chest pain, acute STEMI on ECG, prognosis of weeks (due to chronic disease), arrival from LTC |

| Initial Assessment | Investigations | Walk Test |
|---|---|---|
| **+1** Hx of stroke or TIA<br>**+2** Hx of intubation for respiratory distress<br>**+2** HR >110 on ED arrival<br>**+1** $SaO_2$ < 90% on EMS or ED arrival | **+2** New ischemic changes on ECG<br>**+1** BUN>12mmol/L<br>**+2** $HCO_3$>35mmol/L<br>**+2** Elevated TnI<br>**+1** ProBNP>5µg/L | **+1** $SaO_2$<90%, HR>110 during 3-min walk test, or too ill to walk |

| Interpretation | **Total score = 0 to 15**<br>**Score of 0** = 2.8% risk of serious adverse event within 14d<br>**Score of 9** = 89% risk of serious adverse event within 14d |
|---|---|

## Ottawa TIA Risk Score

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Age >18, ED diagnosis of TIA | Confirmed stroke, decreased LOC, presentation >7 days following onset of most recent TIA |

| Clinical Findings | Investigations |
|---|---|
| **+2** First TIA (in lifetime)<br>**+2** Symptoms >10 min<br>**+2** History of carotid stenosis<br>**+3** Already on antiplatelet therapy<br>**+1** History of gait disturbance<br>**+1** History of unilateral weakness<br>**-3** History of vertigo<br>**+3** Initial triage diastolic BP >110mmHg<br>**+1** Dysarthria or aphasia (history of examination) | **+2** Afib on ECG<br>**+1** New or old infarction on CT<br>**+2** Platelet count >400<br>**+3** Glucose >15 |

| Interpretation | **Total score = -3 to 14**<br>**Score of 0** = 0.04% risk of stroke within 7d<br>**Score of 14** = 27.6% risk of stroke within 7d |
|---|---|

Key References: CMAJ 2016; 188(12):E289-298. AEM 2017; 24(3):316-327. Stroke 2014; 45(1):92-100.

# Advanced Cardiac Life Support

## Electrical Cardioversion

| Indications |
|---|
| Paroxysmal SVT<br>Atrial fibrillation/Atrial flutter<br>Ventricular Tachycardia |
| **Pre-medication** |
| Midazolam 1-5mg +/- fentanyl 50-200µg<br>Propofol 50-150mg IV<br>Ketamine 0.25-1.5mg/kg IV<br>Etomidate 20mg IV |
| **Synchronized Cardioversion** |
| pSVT/Aflutter: 150J biphasic or 300J monophasic<br>Vtach/Afib: 200J biphasic or 360J monophasic |

## Atrial Fibrillation or Atrial Flutter

| General |
|---|
| Assess ABCs, monitors, O2, IV access, ECG to confirm Afib |
| **1. Rapid AF/AFL secondary to medical causes?** |
| Treat underlying causes (eg sepsis, bleeding, PE, CHF, ACS, alcohol withdrawal) |
| **2. Unstable from primary AF/AFL? (rare except WPW)?** |
| Synchronized cardioversion |
| **3. Stable?** |
| **a) Rhythm Control:** Cardioversion or Procainamide 15 mg/kg IV over 60 min: safe if anticoagulated 3 weeks OR no valvular disease/prior TIA and <12hr or <48hr if CHADS-65 <2 |
| **b) Rate Control:** target <100: Diltiazem 0.25mg/kg IV or Metoprolol 5 m; second line: Digoxin 0.25-0.5mg IV |

## Ventricular Fibrillation/Pulseless Ventricular Tachycardia

| General |
|---|
| Intubate, ventilation, early IV/IO access to administer medications<br>Treat reversible causes: hypovolemia, hypoxia, acidosis, hyper/hypokalemia, hypothermia, toxins, ischemia |
| **Shock-CPR-shock cycles** |
| 1. Shock first (200J biphasic or 360J monophasic)<br>**If defibrillator not immediately available start CPR,** then shock ASAP<br>2. High quality CPR for 2 min<br>Push hard (2-2.4 inches) and fast (100-120/min), complete chest recoil, minimize interruptions, avoid excessive ventilations (10/min), change compressors q2min, monitor end-tidal $CO_2$<br>3. Shock |
| **Drugs provided during CPR** |
| **Epinephrine:** 1mg IV q3-5min<br>**Amiodarone:** 300mg IV bolus (preferred), 150mg IV (2nd dose)<br>**Lidocaine** for refractory VF: 1.5mg/kg IV q3-5min (max 3mg/kg)<br>**Magnesium sulfate** for polymorphic VT: 2g IV |

Key Reference: 2021 CAEP AF/AFL Best Practice Checklist.

# Advanced Cardiac Life Support

## Wide Complex Tachycardia (85-95% = VT)

| General | |
|---|---|
| Assess ABCs if stable, monitors, $O_2$, vitals, IV access, ECG, CXR | |
| **Unstable** | **Chest pain, SOB, LOC, low BP, CHF, AMI** |
| Prepare for synchronized cardioversion (200J biphasic or 360J monophasic)<br>Consider premedication | |
| **Stable** | **Consider cardioversion (as meds only revert VT 30% time)** |
| **Procainamide:** 20-50mg/min (max 17mg/kg)<br>**Amiodarone:** 150mg over 10 mins (repeat x2 PRN)<br>**Magnesium sulfate** for polymorphic VT: 2g IV<br>*Avoid multiple antidysrhythmics sequentially (to prevent proarrhythmogenic effects). If one fails, go to electrical cardioversion. | |

## Paroxysmal Supraventricular Tachycardia (AVnRT, AVRT)

| **Unstable** | **Chest pain, SOB, LOC, low BP, CHF, AMI** |
|---|---|
| Synchronized cardioversion (150J biphasic or 300J monophasic)<br>Consider premedication | |
| **Stable** | |
| **Vagal Manoeuvres**<br>**Adenosine:** 6mg IV over 3 secs (1st dose), 12mg IV (2nd dose)<br>**Diltiazem:** 20mg IV over 2 min (1st dose), 25mg IV (2nd dose) | |

## Pulseless Electrical Activity or Asystole

| General |
|---|
| Intubate, ventilation, early IV/IO access to administer medications, PoCUS |
| **Management** |
| **1.** Ongoing CPR<br>**2.** Treat reversible causes: **5Hs** (**H**ypovolemia, **H**ypoxia, **H**ydrogen acidosis, **H**yper/hypokalemia, **H**ypothermia) and **5Ts** (**T**oxins, **T**amponade, **T**ension pneumothorax, **T**hrombosis – coronary, **T**hrombosis – pulmonary)<br>**3.** Epinephrine 1mg IV q3-5mins |

## Bradycardia (HR <60)

| General |
|---|
| ABCs, monitors, O2, vitals, IV access, ECG |
| **Identify and treat reversible causes** |
| i.e. O2 for hypoxia, Ca for hyperkalemia, reperfusion for STEMI |
| **Unstable from bradyarrhythmia** |
| Atropine 0.5mg q3-5min (max 3mg) Not effective for 3º heart block<br>Transcutaneous pacing →Transvenous pacing<br>Consider infusions: Dopamine 2-10µg/kg/min OR Epinephrine 2-10µg/min |
| **Stable** |
| 1ºAV block or Type I 2ºAV block: Observe<br>Type II 2ºAV block or 3ºAV block: transcutaneous pacing → transvenous pacing |

# Point of Care Ultrasound

## Definitions

**Hyperechoic:** object is more echogenic (brighter) than surrounding tissue
**Hypoechoic:** object is less echogenic (less bright) than surrounding tissue
**Isoechoic:** object has same echogenicity than surrounding tissue
**Anechoic:** object has absence of echoes within it
**Near field:** area closer to probe **Far field:** area farther from probe

## Recommended Probe Selection

| | Abdo | Cardiac | Lung | Gyne | Soft Tissue | MSK |
|---|---|---|---|---|---|---|
| **Curvilinear** | + | - | + | + | - | - |
| **Phased Array** | + | + | + | - | - | - |
| **Linear** | - | - | + | - | + | + |
| **Intracavitary** | - | - | - | + | - | - |

## Ultrasound Artifacts

**Acoustic shadowing:** shadow distal to reflective surface (i.e. bone, gallstone)
**Acoustic enhancement:** posterior enhancement due to transmission through a fluid filled structure
**Edge artifact:** refraction of U/S waves due to two different propagation speeds
**Reverberation artifact:** sound bouncing between highly reflective surfaces and probe (i.e. metal needle)

## Cardiac

**Clinical questions:** Is there a pericardial effusion? Is there cardiac activity? Is the LV function reduced? Is there RV strain?
**Exam:**

| **Parasternal Long Axis: assess LV function** |
|---|
| **Fractional shortening <30%** indicates reduced LV function<br>Assessed by the difference in LV diameter between end diastole and systole.<br>**E-point septal separation >7mm** indicates reduced LV function<br>Assessed by looking at the septal slap between anterior mitral valve leaflet and septum.<br>**Fractional shortening ~100% or EPSS ~0mm** indicates hyperdynamic LV<br>Can be seen when ventricles are "kissing" or empty |
| **Parasternal Short Axis: assess LV function, some indication of RV function** |
| **Fractional shortening <30%** indicates reduced LV function<br>**RV larger than LV or "D-shaped" LV** may indicate RV pressure overload |
| **Apical 4 Chamber View: assess RV function** |
| **RV = LV or RV > LV** suggests right heart strain |
| **Subxiphoid View: assess pericardial effusion** |
| Anechoic area first appearing between pericardium and RV, can expand to encompass all 4 chambers |

## AAA

**Clinical questions:** Is there an abdominal aneurysm?
**Exam:** Transverse view using curvilinear probe, max AP diameter >3cm may indicate AAA. Does not necessarily provide information of whether it is ruptured or not.

Key References: Boyd, Jeremy S., et al. "EMERGENCY ULTRASOUND." *The Atlas of Emergency Medicine, 4e* Eds. Kevin J. Knoop, et al. New York, NY: McGraw-Hill.

# Point of Care Ultrasound

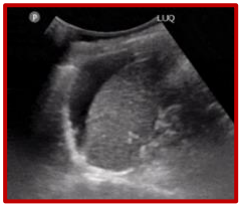
## eFAST

**Clinical questions:** Is there evidence of pneumothorax or free fluid in the abdomen?

**Exam:** Curvilinear probe to look at RUQ, LUQ, and suprapubic areas. Free fluid will appear anechoic, collects early near the caudal edge of liver (RUQ).

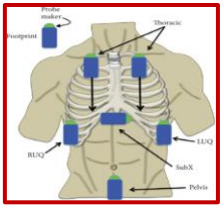
Right and left thorax views using cardiac or curvilinear probe. Absence of lung sliding in pneumothorax.

Positive LUQ




Positive RUQ

eFAST Views




## Lung

**Clinical questions:** Is there pneumothorax? Is there hemothorax or pleural effusion?

**Exam:** Curvilinear probe along mid axillary line at the level of diaphragm

**Mirror sign** – interface between liquid and air-filled thorax will create a highly reflective surface for sound. Absent mirror sign in fluid-filled thorax (i.e. in hemothorax or pleural effusion).

**Spine sign** – visualized when anechoic or hypoechoic fluid is present in the pleural space.

**Lung sliding** – shimmering appearance of pleura, "ants marching on a log". Absent lung sliding may indicate pneumothorax.

Spine Sign

## First Trimester

**Clinical questions:** Is there an intrauterine pregnancy?

**Exam:** Curvilinear probe along midline sagittal view

| **Diagnosis of IUP on POCUS** |
|---|
| Confirm **bladder-uterine juxtaposition** to identify the uterus |
| **Gestational sac** within the uterus<br>Circular anechoic intrauterine area surrounded by thickened echogenic rim |
| **Yolk sac OR fetal pole** visualized within the gestational sac<br>Yolk sac is circular structure with hypoechoic centre within the gestational sac<br>Fetal pole is a small mass at the margin of yolk sac present between 5-6 weeks |
| **Myometrial mantle >8mm**<br>Uterine tissue surrounding gestational sac |

EMOttawa Blog POCUS Manual

Key References: Boyd, Jeremy S., et al. "EMERGENCY ULTRASOUND." *The Atlas of Emergency Medicine, 4e* Eds. Kevin J. Knoop, et al. New York, NY: McGraw-Hill.

# Approach to the Chest X-Ray

**Step 1:** **Confirm details:** patient name, date of birth, MRN, date/time image was taken, previous imaging available (for comparison)

**Step 2:** **Assess image quality** using the mnemonic **RIPE**
**Rotation**: medial aspect of each clavicle should be equidistant from spinous processes & spinous processes vertically oriented against vertebral bodies
**Inspiration**: 8-9 posterior and 5-6 anterior ribs both lung apices, costophrenic angles and lateral rib edges bilaterally
**Projection:** note if the film is AP or PA (more common). AP films magnifies heart and widens mediastinum
**Exposure:** spinous processes should be visible posterior to the heart

**Step 3:** **Assess the CXR for pathology** using the **ABCD approach**

| | |
|---|---|
| **Airway** | **Trachea:** deviation (suggests tension pneumo)<br>**Carina:** NG tube should bisect carina if correctly placed<br>**Bronchi:** right bronchus is wider, shorter, more vertical<br>**Hilar structures:** major pulmonary vasculature & major bronchi, left hilum usually superior to right, assess for hilar masses (hilar asymmetry), lymphadenopathy (LNs should not be visible in healthy pts) |
| **Breathing/ Bones** | **Lungs:** ensure lung markings are present from hilum to chest border (absence indicates pneumothorax), pulmonary edema (peribronchial cuffing, Kerley B lines, septal lines), increased airspace opacification (consolidation/malignant lesion)<br>**Pleura:** if visible indicates pleural thickening (mesothelioma), increased opacity when fluid (hydrothorax), blood (hemothorax) or air and fluid (hydropneumothorax) accumulates in pleural space which appears as area of opacification<br>**Ribs:** fractures |
| **Cardiac** | **Heart size:** cardiomegaly (PA cardiothoracic ratio >0.5) due to valvular heart disease, cardiomyopathy, pulmonary HTN or pericardial effusion<br>**Heart borders:** well defined, silhouette sign suggests pneumonia, RA makes up majority of right & LV majority of left heart borders<br>**Mediastinum:** widening can indicate aortic dissection |
| **Diaphragm** | **Right hemidiaphragm:** usually higher than left<br>**Silhouette sign:** indicates pneumonia<br>**Costophrenic angles:** blunting suggests pleural effusion or consolidation<br>**Flatting:** of diaphragm in hyperinflation (COPD/asthma)<br>**Free air:** indicates pneumoperitoneum and suggests bowel perforation, best seen under right hemidiaphragm<br>**Gastric bubble:** best seen under left diaphragm, don't confuse with pneumoperitoneum |

Key References: Life in the Fast Lane. ABC of Chest X-ray Interpretation. 2020 https://litfl.com/abc-of-cxr-interpretation/.

# Approach to the ECG

**HEARTS:** a systematic approach to ECG interpretation, which puts ST/T in context

**Step 1: H**eart rate/rhythm - how is heart beating? Rhythm strip: rate (300 divided by number large boxes), regularity, QRS width, and whether QRS is driven by sinus rhythm (P wave upright in II, biphasic in V1)

| | |
|---|---|
| **Tachycardia (>100)** | **Narrow Complex:**<br>*Regular:* sinus (P wave), SVT (no P wave), AFL (flutter wave)<br>*Irregular:* PAC (p wave), AF (no P wave), MAT (different P wave)<br>**Wide Complex:**<br>*Regular:* sinus p wave), VT >> SVT with aberrancy (no p wave)<br>*Irregular:* AF with aberrancy, AF with WPW, polymorphic VT |
| **Bradycardia (<60)** | **Narrow Complex:**<br>*Regular:* sinus (p wave+/- 1º AV block), junctional (no p wave)<br>*Irregular:* 2º AV block (dropped beat preceded by PR prolongation in Mobitz 1 vs fixed PR in Mobitz 2)<br>**Wide Complex:**<br>*Regular:* 3º AV block (p wave dissociated), idioventricular (no p wave) |

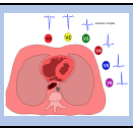
**Step 2: E**lectrical conduction - how is conduction flowing? Rhythm strip: look at the three intervals

| | |
|---|---|
| **PR Interval** | Represents **AV nodal conduction**<br>*Normal:* 120-200ms (3-5 small boxes)<br>*Short:* accessory pathway (WPW) if delta wave<br>*Long:* AV delay, including 1º (fixed long) and 2º Type 1 (prolonged PR until dropped beat) |
| **QRS Interval** | Represents **ventricular conduction**<br>*Narrow:* <120ms (three small boxes)<br>*Wide:* ventricular rhythm, or atrial rhythm with aberrant conduction (i.e. WPW, BBB, hyperkalemia, sodium channel blockade) |
| **QT Interval** | Represents total **ventricular depolarization/repolarization time**<br>*Normal:* <1/2 RR interval, correct for rate: QTc = QT//RR<br>*Prolonged:* >500ms risk Torsades (polymorphic VT with long QT) |

**Step 3: A**xis - what is the main direction of depolarization in the frontal plane? Limb leads: look at direction of QRS in lead I, aVF, +/- II

| | |
|---|---|
| | Represents **left/right myocardium and conduction**<br>***Normal:*** positive I, positive AVF (going left/down)<br>***Right:*** negative I, positive aVF (going right/down)<br>DDx: RV strain, lateral Q, left post. fascicular block, lead misplaced<br>***Left:*** positive I, negative aVF and II (going left/up)<br>DDx: LVH, inferior Q, left ant. fascicular block, lead misplaced |

**Step 4: R**-wave progression: main direction of depolarization in horizontal plane? Chest leads: look at R/S ratio as it progresses from V1 to V6

| | |
|---|---|
|  | Represents **anterior/posterior myocardium and conduction**<br>*Normal:* R<S in V1, R>S by V3-4<br>*Early:* R>S in V1 or V2<br>• DDx: RBBB, WPW, RVH, posterior MI<br>*Late:* no R>S by V4<br>• DDx: anterior MI, LVH, left anterior fascicular block |

**Step 5: T**all/small voltages - what is overall amplitude of depolarization? Limb and chest leads: look at overall QRS amplitude

Represents **viable myocardium and barrier between ECG leads and heart**
**Tall:** normal in young/healthy
- DDx LVH (R>11 in aVL, S in V1-2 + R in V5-6 >35), RVH (R>S in V1, right axis)

**Small:** all limb leads <5mm or all chest leads <10mm
- DDx: breast/adipose tissue, COPD, pericardial effusion, cardiomyopathy

**Step 6: S**T/T changes - any repolarization changes, secondary vs primary? Look at all leads, interpret ST/T changes in context of preceding QRS (abnormal depolarization will produce secondary repolarization abnormalities).

Consider regional/reciprocal leads:
- **Limbs Leads:** inferior lead III reciprocal to high lateral lead aVL; apex lead II reciprocal to aVR
- **Chest Leads:** anterior leads (V3-4) reciprocal to posterior leads (V8-9); septal leads V1-2 reciprocal to lateral leads (V5-6)

| | |
|---|---|
| **ST Elevation (STE)** | **Normal:** isoelectric, except for 1 mm STE in V2-3<br>**ST elevation secondary to abnormal depolarization:**<br>• LBBB/LVH with anterior deep S followed by ST elevation<br>• LV aneurysm: old anterior Q and persisting ST elevation<br>**Primary ST elevation:**<br>• STEMI: regional STE, hyperacute T, reciprocal change<br>• Pericarditis: diffuse concave STE, II>III, reciprocal aVR<br>• Brugada Syndrome: coved or saddleback STE V1-2<br>**Normal variant**:<br>• Early repolarization: STE proportional to large voltage |
| **ST Depression (STD)** | **ST depression secondary to abnormal depolarization**<br>• Tachy-arrhythmia with diffuse ST depression<br>• RBBB/RVH with anterior tall R followed by STD<br>• LBBB/LVH with lateral tall R followed by STD<br>**Primary ST depression**<br>• Acute coronary occlusion: STD reciprocal to STE (i.e. posterior MI), deWinter T wave (STD + hyperacute T)<br>• Subendocardial ischemia: diffuse ischemic STD with reciprocal STE in aVR<br>• Hypokalemia: diffuse STD with, flat T, large U wave |
| **Tall T Wave** | **Normal:** asymmetric, small relative to QRS, concordant to QRS (upright except aVR/V1, sometimes aVL/III)<br>**Tall T wave secondary to abnormal depolarization**<br>• LVH/LBBB with deep anterior S followed by tall T wave<br>**Primary tall T wave**<br>• Hyperacute (acute coronary occlusion): symmetric, wide base, large relative to QRS, regional distribution +/- reciprocation<br>• Peaked (hyperkalemia): symmetric, narrow base, sharp peak, diffuse distribution<br>**Normal variant**<br>• Early repolarization: tall asymmetric T proportional to large voltage |
| **T Wave Inversion (TWI)** | **Secondary T wave inversion**<br>• BBB: RBBB anterior TWI, LBBB lateral TWI<br>• Hypertrophy: RVH anterior TWI, LVH lateral TWI<br>**Primary T wave inversion**<br>• PE: anterior/inferior TWI<br>• Coronary occlusion: TWI reciprocal to hyperacute T wave, or from refractory occlusion<br>• Coronary reperfusion (Wellens): resolved chest pain with reperfusion TWI<br>• Stress cardiomyopathy: diffuse TWI with long QT |

Key References: Life in the Fast Lane. ECG Library Basics. 2020 https://litfl.com/ecg-library/
ECG Cases Blog: emergencymedicinecases.com/blogs/ecg-cases.

End